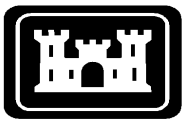

US Army Corps
of Engineers
Omaha District

Annual Report - 1998

Tributary Reservoir Regulation Activities

(August 1997 - July 1998)

Prepared by:
Hydrology and Water Control Section
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December 1998

ANNUAL REPORT - 1998
TRIBUTARY RESERVOIR REGULATION ACTIVITIES
(AUGUST 1997 - JULY 1998)
NORTHWEST DIVISION
MISSOURI RIVER REGION
OMAHA DISTRICT

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ANNUAL REPORT
TRIBUTARY RESERVOIR REGULATION ACTIVITIES
(AUGUST 1997 - JULY 1998)
NORTHWEST DIVISION
MISSOURI RIVER REGION
OMAHA DISTRICT

I. PURPOSE AND SCOPE. This annual report summarizes significant tributary reservoir regulation activities and tributary flooding within the geographic boundaries of the Omaha District. The period covered by this report is 1 August 1997 through 31 July 1998 and is referred to as the report period.

II. REFERENCES.

a. ER 1110-2-1400, 24 April 1970.

b. ER 1110-2-240, 8 October 1982.

c. Missouri River Division Letter, 1 October, 1970, Subject: Reservoir Regulation Reports.

d. CECW-EH-W Letter, Annual Division Water Control and Water Quality Management Reports, 3 November, 1998

III. RESERVOIRS IN THE OMAHA DISTRICT. The Omaha District, Corps of Engineers, civil works boundaries include 414,900 square miles that comprise the Missouri River watershed upstream of Rulo, Nebraska. See basin map (Plate 1).

a. Reservoirs with Flood Control Storage. There are 36 tributary reservoirs with allocated flood control storage covered in this report, including 25 Corps of Engineers dams and 11 Bureau of Reclamation dams. The Corps of Engineers and Bureau of Reclamation dams are listed on Tables 1 and 2 respectively. The locations of the tributary reservoirs are shown on Plate 1 and pertinent data are presented on Plates 2-9.

b. Reservoirs without Flood Control Storage. Two Corps of Engineers tributary reservoirs without allocated flood control storage are included in this report. Both are subimpoundments of the Missouri River Main Stem Projects and were formed by the construction of relocations for transportation facilities and utilities. Lake Audubon, a subimpoundment of Lake Sakakawea, is located just northeast of Riverdale, North Dakota. Lake Pocasse, a subimpoundment of Lake Oahe, is located near Pollock, South Dakota. Both lakes are used for fish and wildlife and recreational purposes. The two reservoirs are listed on Table 1. Their locations are shown on Plate 1 and pertinent data are presented on Plates 6 and 7.

TABLE 1
CORPS OF ENGINEERS TRIBUTARY RESERVOIRS, OMAHA DISTRICT

Name of Dam	Location	River	Date of Closure	Drainage Area (sq. mi.)	Exclusive Flood Control Storage (Acre-Feet)
1. Bear Creek	Denver, CO	Bear Creek	July 1977	236	28,757
2. Bowman-Haley	Bowman, ND	N. Fork Grand	August 1966	446	72,717
3. Bull Hook	Havre, MT	Bull Hook Creek	October 1955	54	6,500
4. Cedar Canyon	Rapid City, SD	Deadman Gulch	September 1959	0.4	123
5. Chatfield	Denver, CO	South Platte	August 1973	3,018	206,945
6. Cherry Creek	Denver, CO	Cherry Creek	October 1948	386	122,842
7. Cold Brook	Hot Springs, SD	Cold Brook	September 1952	70.5	6,680
8. Cottonwood Springs	Hot Springs, SD	Cottonwood Crk	May 1969	26	7,730
9. Kelly Road	Denver, CO	Westerly Creek	November 1953	10.8	360
10. Papillion No. 11 (Glenn Cunningham Dam)	Omaha, NE	Knight Creek	August 1974	17.8	13,899
11. Papillion No. 16 (Standing Bear Dam)	Omaha, NE	Big Papio Cr.	October 1972	6	3,720
12. Papillion No. 18 (Zorinsky Dam)	Omaha, NE	Boxelder Creek	July 1984	16.4	7,585
13. Papillion No. 20 (Wehrspan Dam)	Omaha. NE	S. Br. Papio Cr.	September 1982	13.1	6,119
14. Pipestem	Jamestown, ND	Pipestem Creek	July 1973	594	137,010
15. Salt Creek No. 2 (Olive Creek Dam)	Lincoln, NE	S. Olive Br.	September 1963	8.2	3,980
16. Salt Creek No. 4 (Bluestem Dam)	Lincoln, NE	N. Olive Br.	September 1962	16.6	7,113
17. Salt Creek No. 8 (Wagon Train Dam)	Lincoln, NE	N. Hickman Br.	September 1962	15.6	6,790
18. Salt Creek No. 9 (Stagecoach Dam)	Lincoln, NE	S. Hickman Br.	August 1963	9.7	4,700
19. Salt Creek No. 10 (Yankee Hill Dam)	Lincoln, NE	Cardwell Br.	October 1965	8.4	5,854
20. Salt Creek No. 12 (Conestoga Dam)	Lincoln, NE	Holmes Creek	September 1963	15.1	8,030
21. Salt Creek No. 13 (Twin Lakes Dam)	Lincoln, NE	Middle Creek	September 1965	11.0	5,250

TABLE 1 (CONTINUED)

Name of Dam	Location	River	Date of Closure	Drainage Area (sq. mi.)	Exclusive Flood Control Storage (Acre-Feet)
22. Salt Creek No. 14 (Pawnee Dam)	Lincoln, NE	N. Middle Creek	July 1964	35.9	20,290
23. Salt Creek No. 17 (Antelope Creek Dam)	Lincoln, NE	Antelope Creek	September 1962	5.4	5,885
24. Salt Creek No. 18 (Branched Oak Dam)	Lincoln, NE	Oak Creek	August 1967	88.7	71,570
25. Westerly Creek	Denver, CO	Westerly Creek	October 1990	9.3	4,150
26. Spring Creek Dam (Lake Pocasse)	Pollock, SD	Spring Creek	1961	660	0
27. Snake Creek Dam (Lake Audubon)	Riverdale, ND	Snake Creek	1952	250	0

TABLE 2
BUREAU OF RECLAMATION TRIBUTARY RESERVOIRS, OMAHA DISTRICT

Name of Dam	Location	River	Date of Closure	Drainage Area (sq. mi.)	Exclusive Flood Control Storage (acre-feet)
1. Boysen	Thermopolis, WY	Wind	October 1951	7,710	150,400
2. Canyon Ferry	Helena, MT	Missouri	March 1953	15,900	99,460
3. Clark Canyon	Dillon, MT	Beaverhead	August 1964	2,320	79,090
4. Glendo	Glendo, WY	North Platte	June 1956	14,330	271,900
5. Heart Butte	Glen Ullin, ND	Heart	August 1949	1,710	147,900
6. Jamestown	Jamestown, ND	James	May 1953	1,300	185,400
7. Keyhole	Moorcroft, WY	Belle Fourche	March 1952	1,950	140,500
8. Pactola	Rapid City, SD	Rapid Creek	August 1956	319	43,057
9. Shadehill	Shadehill, SD	Grand	July 1950	3,120	218,300
10. Tiber	Chester, MT	Marias	October 1950	4,850	400,900
11. Yellowtail	Hardin, MT	Bighorn	December 1966	19,626	258,330

IV. TRIBUTARY RUNOFF AND FLOODS.

a. General Hydrologic Conditions.

(1) Long-Term Trends.

The generally moist conditions, which have dominated the District since 1993 continued during 1997 and 1998. The dry conditions which had invaded Colorado, Montana and Wyoming in late 1996 had been largely eliminated by the late summer and early fall of 1997 as shown in Figures 1 and 2. While dry pockets remained in portions of the Rocky Mountain States, more than 75% of the District had average to above average moisture conditions, as defined by the long-term Palmer method.

Average to above average moisture conditions continued into Spring 1998, with only one area near Ft. Peck, Montana showing sub-par moisture as shown on Figure 3. Wet to excessively wet conditions continued over the eastern part of the District, while the "Fort Peck dry pocket" expanded southward into Wyoming by late July 1998, as shown on Figure 4. Some areas of the District, notably northeastern South Dakota continued to experience excessively wet conditions for the 6th or 7th year in a row.

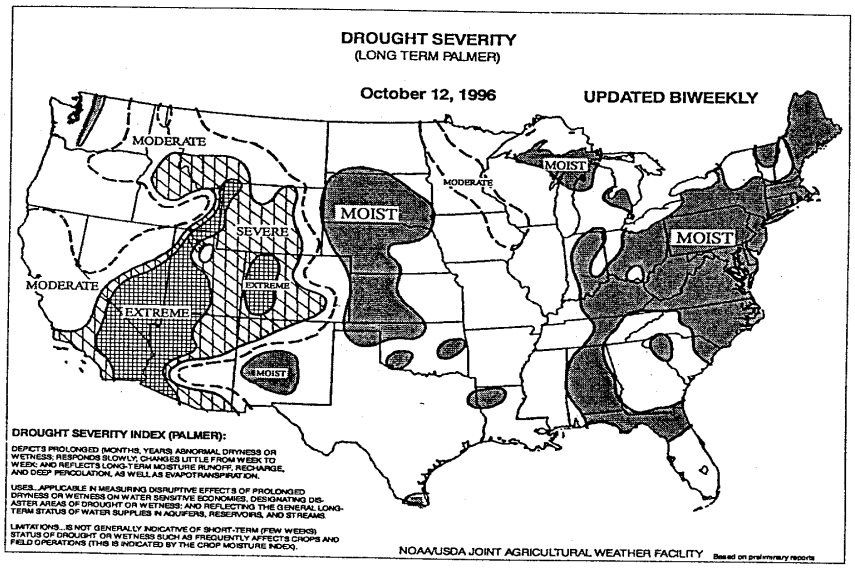


FIGURE 1
FALL 1996 LONG-TERM PALMER DROUGHT SEVERITY INDEX

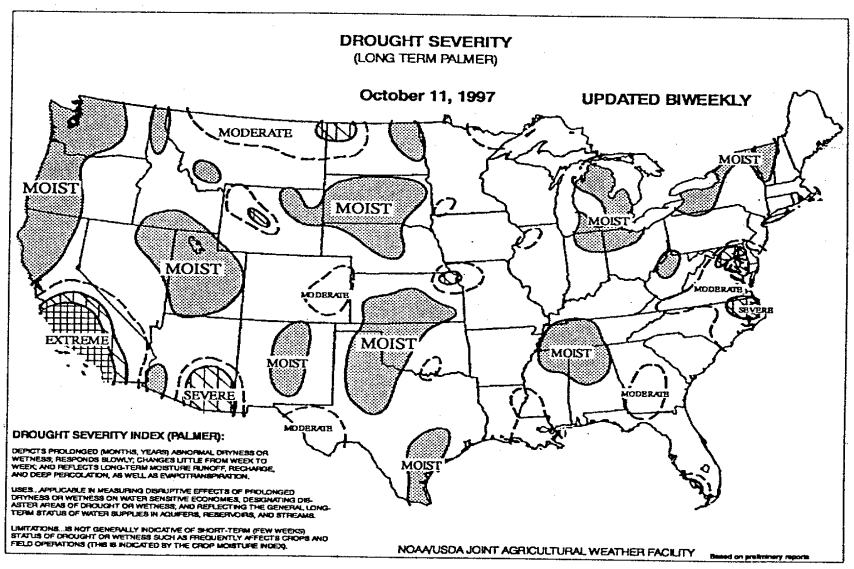


FIGURE 2
FALL 1997 LONG-TERM PALMER DROUGHT SEVERITY INDEX

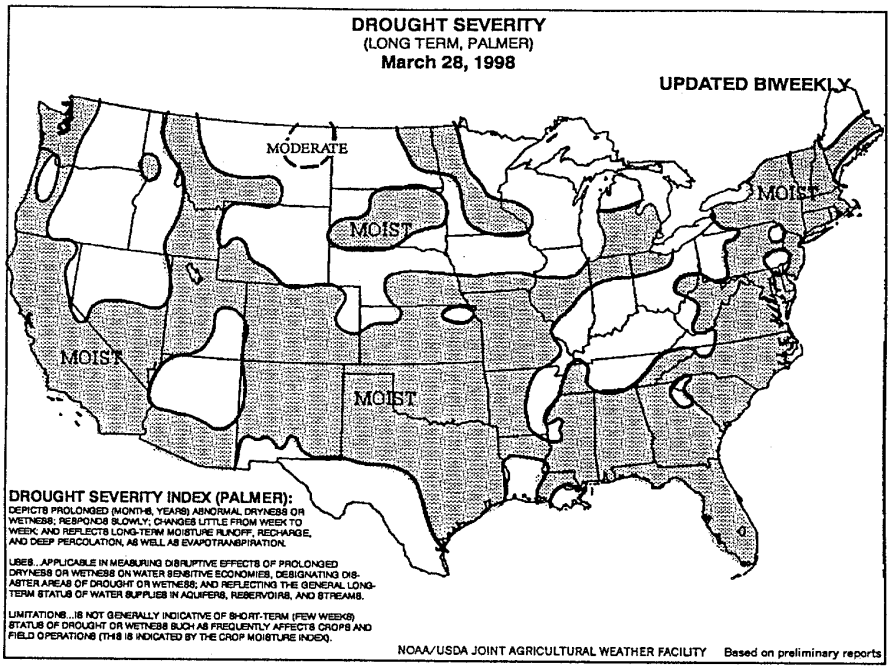


FIGURE 3
SPRING 1998 LONG-TERM PALMER DROUGHT SEVERITY INDEX

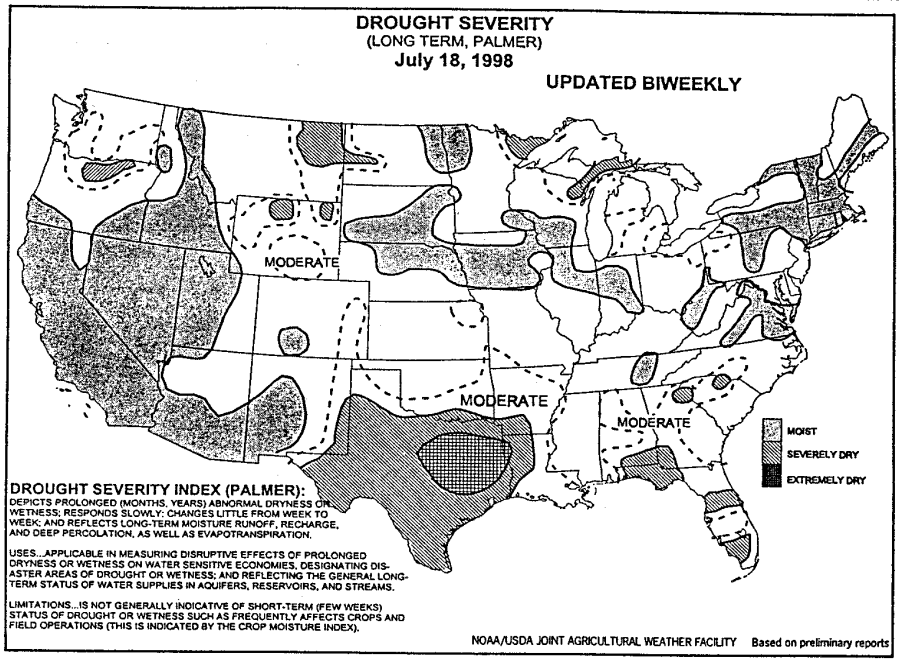


FIGURE 4
SUMMER 1998 LONG-TERM PALMER DROUGHT SEVERITY INDEX

(2) Rocky Mountain Snowmelt.

The Rocky Mountain snow pack for the winter of 1997 – 1998 was average to below average. The South Platte River basin in Colorado had above average snow pack at the start of the season. The snow pack gained ground again in April, as several late season snowstorms added significant snow mass. Snow pack conditions are given in Table 3 below.

The snowmelt in Colorado and in the other Rocky Mountain States was largely uneventful. Warm days were followed by cool nights, which allowed the snow to melt relatively slowly. Rain fell on basins where streams and rivers were already running high from seasonal snowmelt in the Missouri basin headwaters of Montana in June. The combination of the rainfall and the recession of the snowmelt runoff resulted in some flooding.

TABLE 3
MOUNTAIN SNOW PACK MOISTURE AS A PERCENT OF NORMAL

Date	Missouri Basin Headwaters	Upper Yellowstone River Basin	Upper North Platte River Basin	South Platte River Basin
8-Dec-97	81	82	76	110
21-Jan-98	97	98	88	99
18-Feb-98	86	86	85	91
18-Mar-98	84	82	88	92
22-Apr-98	95	90	96	108
20-May-98	82	67	80	95
3-Jun-98	85	49	74	29

(3) Glacial Lakes Flood"

The Waubay Lakes area of South Dakota continued to remain under a threat of additional significant lake elevation increases at the end of July 1998. The closed basin, which has historic drainage ties to the upper Big Sioux River basin, lies between the Big Sioux, James, Minnesota and Red River watersheds. Above average precipitation since the early 1990s has resulted in a steady increase in lake levels to above record stages in the area around Waubay, South Dakota, and much of eastern South Dakota.

Lowlands became sloughs, sloughs became lakes and lakes have grown and merged with other lakes across a wide area of eastern South Dakota. Farmland,

homes, rail lines, county roads and highways have fallen victim to the water's advance, particularly in Day County. By mid-1998, the lakes posed a credible threat to the town of Waubay and had already destroyed some homes along Blue Dog Lake in the northern part of the town. An advanced measures levee was constructed along the western edge of the town in July to protect it from Little Rush Lake.

Lake elevation increases came quickly from storms in the spring of 1998. Elevations rose from 1801.34 feet above mean sea level (ft-msl) on April 14, 1998 to 1803.0 ft-msl by June 22, 1998. This followed a rise from 1799.98 ft-msl on November 14, 1997 to the April reading of 1801.34 ft-msl. A summary of spring rainstorms and their impact on lake elevation are listed in Table 4 as follows:

TABLE 4
RESPONSE OF WAUBAY LAKE, SD TO SPRING RAINFALL

Date	Reported Rainfall	Waubay Lake Rise
26-Apr-98	2.95"	0.47'
12-May-98	3.80"	0.70'
12-Jun-98	1.50"	0.20'

b. Significant Weather Events, August 1997 through July 1998.

(1) Late Summer 1997.

In early August 1997, a strong monsoonal flow continued to support flash flooding near the Front Range of the Rockies. A persistent upper-level system over the central Rockies acted as a conveyer belt to move tropical moisture northward into the high plains, where daily heating and upslope winds combined to produce powerful thunderstorms nearly every afternoon. The result was heavy rains and hail on a daily basis, somewhere in the high plains or foothills.

High water also continued on the Missouri River in western North Dakota, with gage heights at Williston about 3 feet above flood stage due to heavy rain in July and high releases from Ft. Peck Dam. High releases from the other Missouri Mainstem Dams also resulted in high within-bank stages on the Missouri River during late summer. Reservoirs near Hot Springs, South Dakota, remained near record pool elevations on August 1st following the 8.05 inches of rain recorded at Hot Springs in the month of July.

Flash flooding occurred on Box Elder Creek near Nemo, South Dakota, on

August 1st, as a stationary thunderstorm dumped very heavy rain over parts of the Black Hills. More flash flooding was reported in the Nebraska Panhandle and the South Dakota Badlands on the 2nd and in northeast Colorado and southeast Wyoming on the 4th. More than 5 inches of rain fell near Hillrose, Colorado, on the evening of the 4th, causing flood waters to cover Highway 6 east of Hillrose. Minor flooding was reported in the Denver area. None of the flash floods affected Corps projects.

Saturated soil conditions in the Ft. Collins, Colorado, area from the flooding in late July resulted in more lowland and street flooding on August 5th as 2 inches of rain fell in a short time. The pattern of daily flash flooding along the Front Range subsided somewhat, following additional heavy thunderstorms in northeast Colorado on August 6th.

Severe weather returned to the northcentral plains by August 13th as a strong upper-level storm system deepened over the Dakotas. Heavy thunderstorms dumped rainfalls of 2 to 4 inches in several locations, which caused minor flooding near Rapid City, Aberdeen and Pierre, South Dakota, and on the South Loup River near Ravenna, Nebraska. Following the thunderstorm outbreak on the 13th, storms in the District did not produce significant flash flooding until the end of August.

Another period of heavy rain and flash flooding began over parts of Colorado, Nebraska, Iowa and North Dakota as a cold front pushed into warm moist air moving northward from the Gulf of Mexico at the beginning of September. Heavy rains fell in the Denver area, upstream of Cherry Creek and Chatfield Reservoirs, causing minor lowland flooding on the night of August 31st and the morning of September 1st. Severe thunderstorms also dumped up to 4 inches of rain upstream of Jamestown Reservoir near Jamestown, North Dakota. The Missouri River at Williston remained 1.7 feet above flood stage on September 1st.

Three to more than 6 inches of rain fell over eastern Nebraska and Western Iowa the night of September 1st, pushing streams in the Papillion Creek watershed above flood stage near Elkhorn, Ralston and Bellevue, Nebraska. Greater damage was prevented by four Corps reservoirs in the basin, and warnings generated by the Corps sponsored ALERT flood warning system provided time to close most of the roads in the flood plain. Lowland flooding was reported on Maple Creek near Nickerson, Nebraska, and other Elkhorn River tributaries. Additional lowland flooding was reported in parts of the Nishnabotna River basin of western Iowa and in the Tarkio River basin in northwest Missouri.

(2) Fall 1997.

The remnants of Pacific tropical storm Nora brought abundant moisture to the southern part of the District by the last week of September. Thunderstorms became more numerous over Colorado, Nebraska and Iowa. Minor lowland flooding occurred along the Missouri River, from Brownville, Nebraska, downstream as the additional runoff caused the river, already high from above average mainstem dam releases, to overflow by September 27th. Releases for the three downstream reservoirs were as follows on October 1st:

Big Bend (Lake Sharpe)	52,000 cfs
Ft. Randall (Lake Francis Case)	64,000 cfs
Gavins Point (Lewis & Clark Lake)	68,000 cfs

Another storm moved through the District on October 11th and 12th, producing snow at higher elevations of the Black Hills and rains of 1.5 to 2.5 inches across parts of central Nebraska, western Iowa and South Dakota. As tributary streams emptied their runoff the Missouri River at Brownville pushed above flood stage again. The Missouri River at Williston, North Dakota, finally fell below flood stage by mid-October.

Winter weather roared into the southeastern part of the District with a vengeance by October 25th. Blizzard conditions developed as warm moist air from the Gulf of Mexico was fed into a deepening low-pressure system tracking northeastward from Colorado towards Iowa. Precipitation began as moderate to heavy rain, then changed to snow. Thunderstorms with heavy snow produced a band of heavy snow from 1 to 2 feet deep from central Nebraska into western Iowa, damaging or destroying many trees, which still had fall foliage. Lincoln, Nebraska, had among the heaviest precipitation from the storm with 3.31 inches reported on October 26th, which included 14 inches of snow. Temperatures behind the blizzard plunged to below zero readings in the Nebraska panhandle and eastern Wyoming to low teens in the eastern part of Nebraska, breaking many low temperature records. Runoff from the rain ahead of the blizzard and snowmelt, once again pushed the Missouri River at Brownville and Rulo 1 to 2 feet above flood stage by October 28th.

Following the blizzard, mild and dry weather returned to the District until November 12th, when another snowstorm moved out of the northern Rockies and across the Dakotas dropping 2 to 6 inches of snow on the plains and larger amounts in the mountains. More rain and snow moved in by November 28th. By December 1st, the Missouri River again rose above flood stage from Nebraska City, Nebraska, downstream and the lower Nishnabotna River experienced high within-

bank stages near Hamburg, Iowa. A normal late fall or early winter weather pattern prevailed through mid-December, with many areas receiving light to moderate snow with the passage of fronts and storm systems. Much of that snow melted by Christmas as unusually warm and dry weather spread across the District. The mild conditions were attributed to the El Niño weather phenomenon in the Pacific Ocean.

(3) Winter of 1997 - 1998.

The unseasonably mild conditions prevailed until January 22nd across most of the District, while the mountain snow pack grew at a below average rate. A winter storm dumped 6 to 12 inches of snow across much of eastern South Dakota by the 23rd. The colder temperatures by the 22nd also caused ice jams to form on the Platte River near Fremont, Nebraska. Ice jams in that area grew in scope and coverage through early February.

Mild weather returned by mid-February, with temperatures well above normal. Rainfall on partially frozen ground in the East Nishnabotna River basin caused the Nishnabotna River at Hamburg to rise to near flood stage by February 17th. Winter returned to the northern plains between February 24th and March 1st, as a storm emerged from the Rockies and tracked slowly northeastward through northern Nebraska towards Minnesota. Rare February thunderstorms pushed northward into eastern South Dakota ahead of the storm. Over a foot of snow fell across parts of Wyoming, eastern Montana, western Nebraska and the western Dakotas. Seven to eight feet of snow fell in the northern Black Hills, with Galena, South Dakota, recording the most, with 94 inches of new snow by March 1st after several days of blizzard conditions. Rain on frozen ground and snowmelt in the James and Big Sioux River basins ahead of the storm center caused the rivers to rise towards flood stage.

A second late winter storm developed in the southern Rockies and tracked northeast toward Nebraska on March 7th and 8th, producing heavy snow in Nebraska, Iowa and parts of South Dakota. Depths of 12 to 18 inches were reported across southeast Nebraska and western Iowa by March 9th. An additional 6 to 12 inches of snow fell in the Black Hills and Badlands of South Dakota, adding to the snow pack from the earlier storm. Temperatures in Wyoming and the western Dakotas plummeted to –20° to –40° F behind the storm. Hettinger, North Dakota, reported –38° F on March 11th and Midland, South Dakota, reported –34° F on the 12th. Subzero temperatures in eastern Nebraska caused a redevelopment of ice jams and lowland flooding along the Platte River between Fremont and Ashland, Nebraska, by March 15th.

Another winter storm pushed into the District by March 16th, as an upper level storm system moved eastward from the Rockies. Rain, freezing rain, and snow were reported over most of the District on March 17th and 18th. The heaviest amounts were reported in the Rocky Mountains from Colorado northward into Montana.

(4) Spring 1998.

By March 23rd, much warmer temperatures moved into the District and the plains snow began to melt. Snowmelt in eastern Wyoming and western Nebraska caused stages on the North Platte River to rise to nearly flood stage from Henry to Lewellen, Nebraska. By March 26th, the snowmelt was underway throughout the North Platte River basin including the headwaters in Colorado. Melting snow also caused the James River in northern South Dakota and Apple Creek near Menoken, North Dakota, to rise toward flood stage by the 24th.

The end of March brought a return to stormy weather, as an upper-level system off of the West Coast moved inland towards Wyoming and generated a series of storms across the north-central part of the country. More heavy snow developed in the Rockies and northern plains, while rain and thunderstorms moved across the central plains. Rainfall amounts of 1 to 3 inches were reported in central through northeast Nebraska and in central South Dakota on the 28th and 29th ahead of the system. Snowfalls of 4 to 12 inches were reported across parts of Montana, northeast Wyoming and western South Dakota as the system moved eastward.

The Platte, Elkhorn and Loup Rivers rose to near flood stage by March 29th in response to the heavy rain. The additional rainfall also aggravated flooding on the James River in the Dakotas. In addition to the trouble spots in northern South Dakota, the stage on the James River at Pingree, North Dakota, moved above flood stage by March 30th. Minor flooding was also reported along the Big and Little Sioux Rivers of eastern South Dakota and northwest Iowa. Rises to near flood stage were also reported along the lower Nishnabotna River near Hamburg in southwest Iowa.

By March 31st the storm moved northeastward out of the District after dumping 5 to 10 inches of new snow across parts of northeastern South Dakota and adjacent states. Runoff from thunderstorm rainfalls of up to 2.5 inches in southeast Nebraska and southwest Iowa pushed the Missouri River to near flood stage from Brownville downstream.

Heavy snow occurred in the mountains of Colorado as another storm moved into the District by April 2nd. Amounts of 4 to 8 inches of snow fell on the high plains and 12 to 15 inches were reported in the foothills and mountains of the Front Range. Another in the series of storms moved into the District on April 6th, kicking off thunderstorms in Nebraska and western Iowa. Flash flood watches and warnings were issued as rainfall amounts of 2 to more than 4 inches were reported from central Nebraska eastward into southwest Iowa. Flood warnings were issued for the West Nishnabotna River and the lower Nishnabotna River of Iowa.

Storms continued to pound the District through late-April, with additional snowfall adding to Rocky Mountain snow pack in the west while severe thunderstorms raked some locations in the eastern part of the District every few days. Despite the frequent storms, rivers generally receded to below flood stage with the exception of the James River in South Dakota. The snow pack in Colorado pushed to above average levels for the first time during the spring.

May began with similar weather conditions as the District continued to warm. By May 7th, some high level snowmelt flooding was reported on the Beaverhead River in Montana. Only minor overbank flows were reported, as nighttime temperatures fell back to near freezing. Similar melting conditions prevailed in Colorado, so that despite above average snow pack, little flooding resulted. By May 26th the Weather Service in Denver declared that the threat of a snowmelt flood in the Platte River basin was over, due to the gradual melting.

More significant storms returned to the District by May 11th. Two to four inches of rain fell over parts of north central and northeast South Dakota, contributing to flooding along tributaries to the swollen James River and increasing high lake levels in the Waubay Lakes area to all time record levels, and posing a flood threat to Waubay, South Dakota. Severe thunderstorms, with large hail, raked parts of Nebraska as a strong cold front pushed eastward. Thunderstorms including several tornadoes pounded western Iowa and adjacent states on the 15th, with hail and wind damage being the primary result.

Another round of severe weather struck the eastern part of the District a week later on May 22nd. Three to 6 inches of rain were reported in parts of the northern Salt Creek basin north of Lincoln, Nebraska, causing flooding on Wahoo Creek, Rock Creek and the lower portion of Salt Creek. Heavy rains in western Iowa caused the Nishnabotna to rise above flood stage again. Lowland flooding was also reported near Kearney and Rushville, Nebraska as squall lines roared through the western and central part of that state, spawning tornadoes and dumping 2 to 5 inches of rain. The Wood River rose to near flood stage between

Alda and Grand Island, Nebraska, by the 24th and 25th.

More thunderstorms struck eastern Nebraska, western Iowa and eastern South Dakota on the 28th and 29th. Rainfall amounts ranged up to 3.7 inches at Union, Nebraska, and 4 inches at Pacific Junction, Iowa. Weeping Water Creek rose to near flood levels, while the lower Nishnabotna River continued to rise. The Missouri River from Brownville downstream pushed slightly above flood stage again by the 30th in response to the tributary inflows.

Thunderstorms continued to pound some part of the District nearly every night during early June, but no significant flooding was reported until June 13th. Unseasonably cold temperatures caused record late freezes from June 3rd through June 6th across much of the west, with crop losses extending as far south as Kansas.

As the cold high-pressure system moved eastward by the 8th, low pressure to the west brought a strong flow of moisture from the south and a return of increased thunderstorm activity. Rainfall amounts of 1 to 2.5 inches were reported over parts of Nebraska and Iowa on the 11th. The Nishnabotna River and the Missouri River below Nebraska City rose above flood stage by the 12th. This helped set the stage for more serious flooding in watersheds near the Missouri River in the days to come.

Very heavy rains developed over eastern Nebraska and western Iowa as a surface low pressure system moved from northeast Colorado to southwest Iowa on the night of Saturday June 13th – 14th, along a slow moving warm front which was lifting northward from Kansas and Missouri. The low-pressure system became stationary over southwest Iowa, setting the stage for record setting rainfall and flooding in the Nishnabotna River basin. Wrap-around subtropical moisture from the Gulf of Mexico fed persistent rainstorms over western and central Iowa resulting in extremely large rainfall totals.

The rainfall rates were moderate; only about an inch per hour, but the stationary nature of the parent storm allowed the rainfall to continue for 12 to 14 hours at that rate in some portions of the upper Nishnabotna River basin. The heaviest rainfalls occurred in Cass County and adjacent portions of Pottawattamie and Montgomery counties between midnight on June 13th through mid-afternoon on the 14th. By the time it was over, a new official 1 - day rainfall total for the state of Iowa (13.20 inches) had been set at radio station KJAN in Atlantic, Iowa, eclipsing a single day rainfall record set back in the 1890's. Other unofficial rainfall reports gathered during a subsequent bucket survey, ranged up to 15.25 inches in Lewis, Iowa.

In the four days that followed, stream stage records were set at Red Oak and at Hamburg, Iowa, and elsewhere in the basin, as the flood crest made its way downstream towards Hamburg. The peak discharge at Hamburg was estimated to be between 60,000 and 70,000 cfs, based upon current rating curves. The USGS measured nearly 90,000 cfs upstream at Riverton, Iowa, on June 16th, when the flood was near its crest, so the final discharge value may be revised upward. Numerous levees failed from the headwaters to the mouth of the Nishnabotna River, inundating towns, farmland and roads.

Stages on the Missouri River rose as well, during the Nishnabotna River flood. At the time of the crest on the Nishnabotna on June 17th, the Missouri River at Brownville, Nebraska, was more than 4.5 feet above flood stage. Based upon data collected at the Missouri River gage at Nebraska City, Missouri River flows likely approached 100,000 cfs at the mouth of the Nishnabotna River, while that river was near peak stage.

The peak stage of 33.2 feet reached by the Nishnabotna River at Hamburg gage set a new record stage at this station. This exceeds the previous record flood stage of 30.56 feet set on 25 July 1993. Station records go back to 1923. Since the final discharge estimate is not available yet, a frequency has not been assigned to the flood. Based upon the discharge measurement made at Riverton, the flood definitely exceeded the 100-year event.

Flooding continued on the lower Nishnabotna River and the Missouri River from Nebraska City downstream through the end of June, as flood water returned to the channel from flooded fields. Thunderstorms continued to pound other parts of the District as a cold upper-level storm system moved from the northern Rockies onto the northern Plains. Heavy rains of 2.5 to as much as 5 inches fell in northeast Nebraska and in the Dakotas on June 17th and 18th resulting in some lowland flooding, particularly on Shell and Beaver Creeks west of Columbus, Nebraska. Reservoir elevations in the Black Hills rose in response to runoff from those storms. Snow accumulated in the high mountain passes from Colorado through Montana. Minor flooding was also reported in the Beaverhead River basin of Montana, due to above normal rainfall and seasonal snowmelt on the 19th.

(5) Early Summer 1998.

Widespread thunderstorm activity returned to the northern plains by June 23rd, as thunderstorms developed north of an upper level high-pressure ridge centered over Texas. Thunderstorms became more numerous along the Front Range as the circulation around the high-pressure system set up a monsoonal

moisture flow in eastern Colorado, Wyoming and Montana. Two to four inches of rain fell in the South Platte River basin northeast of Denver on the 23rd, with tornadoes and hail reported in Wyoming and several locations in Nebraska. Flash flooding was reported along small streams in northwest Iowa and northeast Nebraska on the 24th. Minor flooding occurred along Pebble and Maple Creeks northwest of Fremont, Nebraska, the Boyer River near Denison, Iowa, and the West Fork Ditch near Hornick, Iowa. The Missouri River pushed above flood stage at Williston, North Dakota, and the Cheyenne River rose to near flood stage at Cherry Creek, South Dakota.

Montana became the focus of storm activity by June 26th. Two to 4 inches of rain added to receding snowmelt runoff and caused flooding of minor streams near Dillon and on the Ft. Belknap Indian Reservation. Continued rain caused larger streams and rivers to rise as well. Water levels rose to around flood stage on many rivers in the south-central part of the state including the Jefferson, Gallatin, Boulder, Big Hole and the upper Missouri Rivers. Even more extreme rain fell on the 27th, when as much as 9 inches of rain were reported near Havre, Montana. Flooding on Montana rivers continued into early July.

Very heavy thunderstorms pounded portions of Nebraska, Iowa and the Dakotas by the 27th, with some locations, such as Britton, South Dakota, receiving more than 5 inches. Since the storms were isolated, only localized flash flooding resulted.

Thunderstorm activity along the Rocky Mountains increased due to a stronger monsoonal flow by early July. Two to six inches of rain caused localized flooding in east central and northeast Wyoming on July 1st. Much of the rain in Campbell County, northeast of Casper, Wyoming, fell in an hour and a half. Stagnant frontal boundaries over the Mid-West continued to provide the focus for severe thunderstorms in the eastern part of the District. Frequent thunderstorms prolonged flooding on the James River of South Dakota, where water levels at Stratford were two feet above flood stage in early July.

Severe thunderstorms pounded eastern Nebraska and western Iowa over the 4th of July weekend. Minor flooding was reported in the Loup and Elkhorn River basins of Nebraska. Heavy rains of 2 to 5 inches in the Omaha area caused Papillion Creek and its tributaries to rise to flood stage early on the 5th. Bell Creek near Arlington, Nebraska, and New York Creek near Herman, Nebraska, also flooded from that storm. The Nishnabotna River and its major tributaries once again rose above flood stage in western Iowa. The Missouri River from Nebraska City downstream, which had been receding, began to rise further above flood stage, with the Missouri River at Brownville 4.5 feet above flood stage by July 6th.

Widespread thunderstorms continued to visit the high plains nearly every night in early July. Thunderstorm complexes on July 8th and 9th produced heavy rains of 2 to 4 inches in many locations. Lowland flooding was reported near Boulder, Colorado, Cheyenne, Wyoming, Crawford, Nebraska, and Great Falls, Montana, as a result of the severe local storms. Eastern Nebraska and Western Iowa were the targets for the heavy rains on the 10th. More than 2.5 inches of rain fell north of Sioux City, which caused Perry Creek to rise to near flood stage upstream of the city, giving the new flood warning system its first successful test. Up to 8 inches of rain fell in parts the Little Nemaha River basin of southeast Nebraska from the same storm system, which caused the Little Nemaha River to crest above flood stage at Auburn, Nebraska. By July 13th dryer and warm weather overspread most of the District, reducing the threat of widespread flooding. Late afternoon and night time thunderstorms continued to cause local runoff problems, particularly along the Front Range and in the Dakotas.

A cold front moving eastward through the District generated more widespread thunderstorm activity and flash flooding by July 21st. Rainfall amounts of 3 to 6 inches were reported near Kimball, Nebraska, causing Lodgepole Creek to flood near Dix, Nebraska. Five to 7 inches of rain fell near Ord, Nebraska, causing flooding on tributaries to the North Loup River. Stages on the Nishnabotna River rose back above flood stage after 5 inches of rain fell in the West Nishnabotna River basin. By July 23rd a nearly stationary front across the high plains generated thunderstorms which caused flooding on Bear Butte Creek near Sturgis, South Dakota, and lowland flooding in parts of northeast Colorado and the Nebraska Panhandle.

Denver became the target of the heavy rain on the 25th, as moisture surged northward into the District ahead of an upper-level storm system. As much as 5.6 inches fell in the city, which caused widespread flooding on urban drainages. From 4 to 8 inches were reported in parts of south central South Dakota, resulting in high water on the White River and its tributaries.

July ended with considerable thunderstorm activity, but little additional flash flooding. Minor stream flooding was reported in southeast Nebraska and southwest Iowa as up to 5 inches of rain fell from Nebraska City, Nebraska, to Hamburg, Iowa, on July 30th.

(c.) Nishnabotna River Flood of June 14-19, 1998

Heavy rains occurred over the Nishnabotna River basin on Sunday, June 14, 1998. These rains followed two weeks of wet and relatively cool conditions that

had saturated basin soils. At Atlantic, Iowa, the total rainfall amount reported of 13.2 inches exceeded the all time record for the state of Iowa for the amount of rain reported during a 24-hour period. A large area of 8 to 10 inch rainfalls occurred over the Nishnabotna basin with the heaviest rainfall centered over the East Nishnabotna basin.

Water Control staff working Sunday morning checked the radar and monitored the storm as it was occurring. The Chiefs of Water Control and Emergency Management were notified and additional staff were called in to assess the situation. About 4 pm Sunday, June 14, the National Weather Service (NWS) issued a flood warning for the East Nishnabotna River from Elliott to Riverton, Iowa. At 4:30 pm the NWS reissued the flood warning for the East Nishnabotna and extended it to include the Nishnabotna River at Hamburg. At that time, the East Nishnabotna River at Red Oak was forecasted to crest at 27.9 feet on Tuesday morning, June 16, and the Nishnabotna River at Hamburg was forecasted to crest at a stage of 30.6 feet on Monday morning. A crew was dispatched to Hamburg to monitor the freeboard at the Highway 275 closure. Preparations for a rainfall bucket survey were initiated Sunday night.

On Monday, June 15, the West Nishnabotna River at Hancock, Iowa crested at a stage of 17.57 feet at 1:15 am with an estimated peak discharge of approximately 15,100 cfs. This stage was 3.6 feet above flood stage and about 6 feet below the previous record stage of 23.5 feet that occurred in 1993 with a peak discharge of 30,100 cfs.

At midnight Monday, June 15th, the West Nishnabotna River crested further downstream at Randolph, Iowa at a stage of 23.92. This crest was approximately 5 feet above flood stage and less than a foot below the previous record stage of 24.8 feet that occurred in 1949. The USGS measured a discharge of 29,100 cfs at 7:15 pm. The estimated peak discharge was about 30,400 cfs.

At Atlantic, Iowa, the East Nishnabotna River crested 23.00 feet at 10:15 am on June 15 with an estimated peak discharge of 41,500 cfs. This stage exceeded the record stage of 22.81 that occurred in September of 1972, and the discharge exceeded the record discharge of 34,200 cfs that occurred in 1958 by about 30 percent.

Further downstream at Red Oak, Iowa, the East Nishnabotna River crested at a stage of 29.39 feet at 3:10 pm on June 15th. This stage was 11.4 feet above flood stage and exceeded the previous record stage of 28.23 feet set in 1947 by 1.16 feet. The USGS measured a discharge of 64,000 cfs at 3:10 pm on June 15. The peak discharge was nearly double the previous record discharge of

38,000 that occurred in 1972. On Monday, June 15, a crew was dispatched to Red Oak, Iowa to monitor the levee. Some seepage and boils were reported during the high water. Although the town was protected by the levee along the East Nishnabotna, some interior flooding occurred due to ponding of water along Red Oak Creek.

On Tuesday, crews were dispatched to conduct the rainfall bucket survey and set high water marks. Four 2-person crews were utilized for the bucket survey including 3 crews provided by a contractor. The bucket survey required 3 days to complete.

Internal forecasts prepared by the Corps indicated that the peak flows at Hamburg could exceed 60,000 cfs and threaten the levee at Hamburg. On the morning of Tuesday, June 16th, the locals were advised to begin sandbagging the low areas along the L-575 tie back downstream from the Burlington Northern (BN) railroad. Because of the record amounts of water flowing in the river upstream, the Corps dispatched crews to install staff gages upstream from Hamburg to monitor river rises. Additional crews were also dispatched for helicopter and ground tours to try and identify the location of the flood crests coming down the West Nishnabotna River and the East Nishnabotna River. The helicopter over-flight was conducted from about 3:30 pm to 5:30 pm on June 16th. The helicopter survey report was phoned back to the water control office where the information was used to dispatch the USGS flow measurement team to the confluence of the East and West Nishnabotna Rivers. Additional crews were also dispatched to Hamburg to monitor the levee and assist locals with flood fight activities.

Staff gages were also installed at Highway 42 near Riverton (about 6 miles upstream from Hamburg), 2 miles downstream from Riverton (about 2 miles upstream from the Hamburg gage), at “O” Street in Hamburg and at the Highway 275 bridge in Hamburg. These staff gages, in addition to the USGS gage located 2 miles upstream from Hamburg, provided valuable information in monitoring the flood event. At Highway 42, it was reported that water overtopped the road sometime in the early morning of June 16th and rose to about 4 feet over the road by early afternoon when the staff gage was installed. It rose an additional 1.4 feet in 2 hours by 3:30 pm. At the gage 2 miles downstream, the stages were already rising at about the time the staff gage was installed at 6:00 pm and rose another 3 feet by midnight.

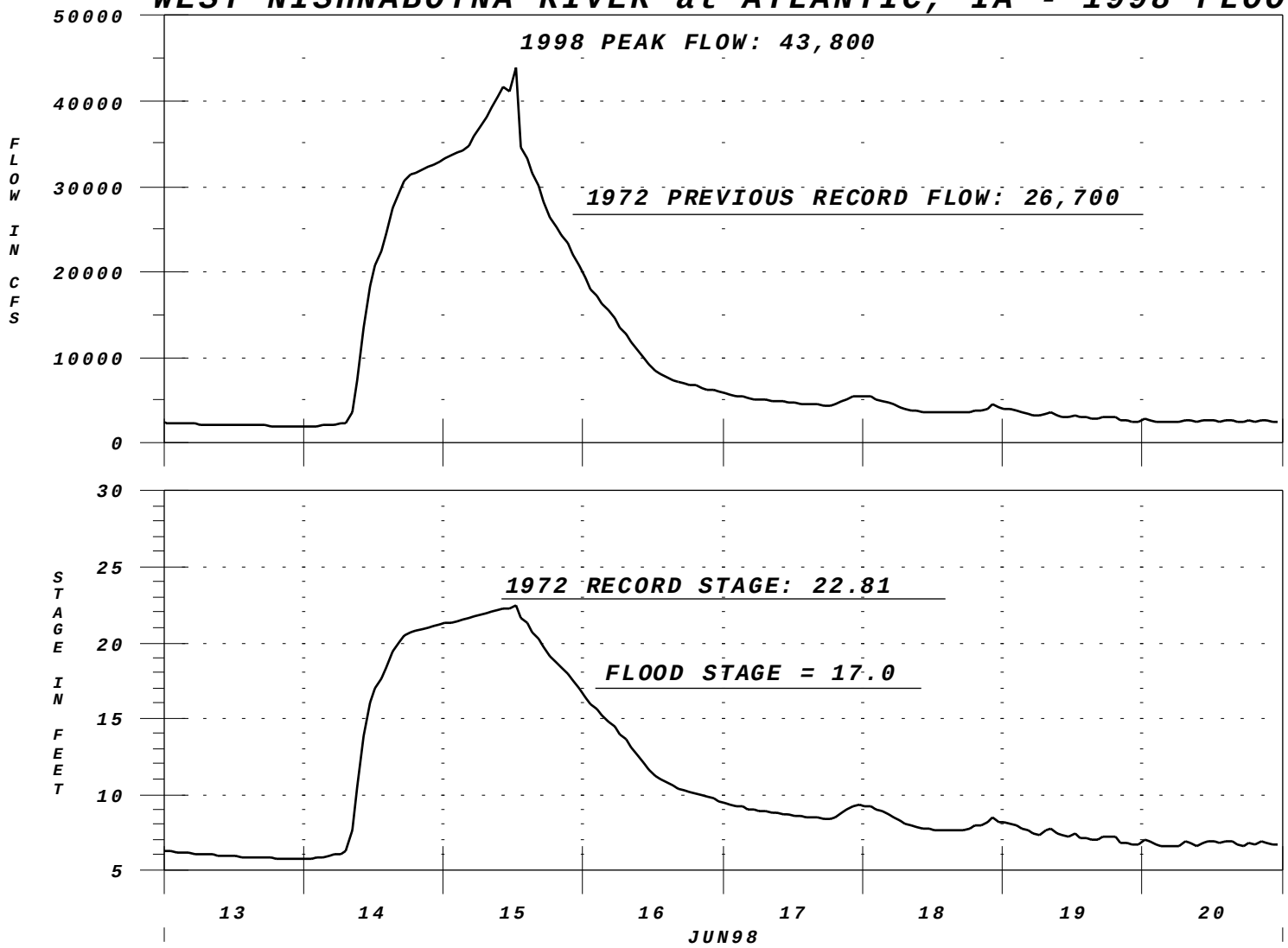
About 9:00 pm on June 16th the USGS finished making a discharge measurement along Highway 42. They measured a total combined flow of 90,000 cfs from both the East Nishnabotna River and West Nishnabotna River.

Because of the 90,000 cfs measurement, the Corps advised the local emergency authorities of the potential for the levee to overtop at Hamburg and recommended evacuation of the low areas of town. The Hamburg levee was designed to pass 47,000 cfs with 2 feet of freeboard. It was estimated that the levee could pass about 60,000 cfs with no freeboard. The NWS was also contacted and informed of the 90,000 cfs discharge measurement. At 10:40 pm the NWS issued a revised flood warning. By 10:45 pm on Tuesday night, the locals began evacuating the City of Hamburg. Shortly before midnight, the stages at the Hamburg gage began rising rapidly. The L-575 tie back levee began overtopping about 2:00 am on June 17th. Water reached near the top of the Hamburg levee in the early morning hours of June 17th, but did not overtop the levee.

The Nishnabotna River at Hamburg crested at a stage of 33.18 feet at 7:30 am on Wednesday morning June 17th. This stage exceeded the previous record stage of 30.56 feet that occurred in 1993 by 2.62 feet. The USGS measured a discharge of 61,200 cfs at 10:00 am on the morning of June 17th. This discharge exceeded the all time record discharge of 55,500 cfs that occurred in 1947 and was nearly double the peak discharge that occurred in 1993. The estimated frequency of the event at Hamburg is .005 percent chance exceedance with an average return interval of once in 200 years.

On Wednesday, June 17th, additional staff gages were installed at the Highway 333/Interstate 29 underpass and at Ditch 6 at the Highway 333 bridge. These staff gages were installed to monitor the Ditch 6 ponding area due to the flow over the l-575 tie back. There was concern about water backing into Hamburg from the ponding area. Locals used flood fight measures to block culverts through I-29 and prevent water from backing through those and sandbagged across the Highway 333 underpass and near the Ditch 6/Highway 333 crossing. Observations at these gages indicated that water was flowing into Ditch 6 from the ponding area. The Ditch 6 pumps were shut down on June 17th due to concerns of running out of fuel and not being able to get additional fuel to the pumps because of the levee overtopping. On Thursday June 18th the pumps were refueled and the pumps restarted.

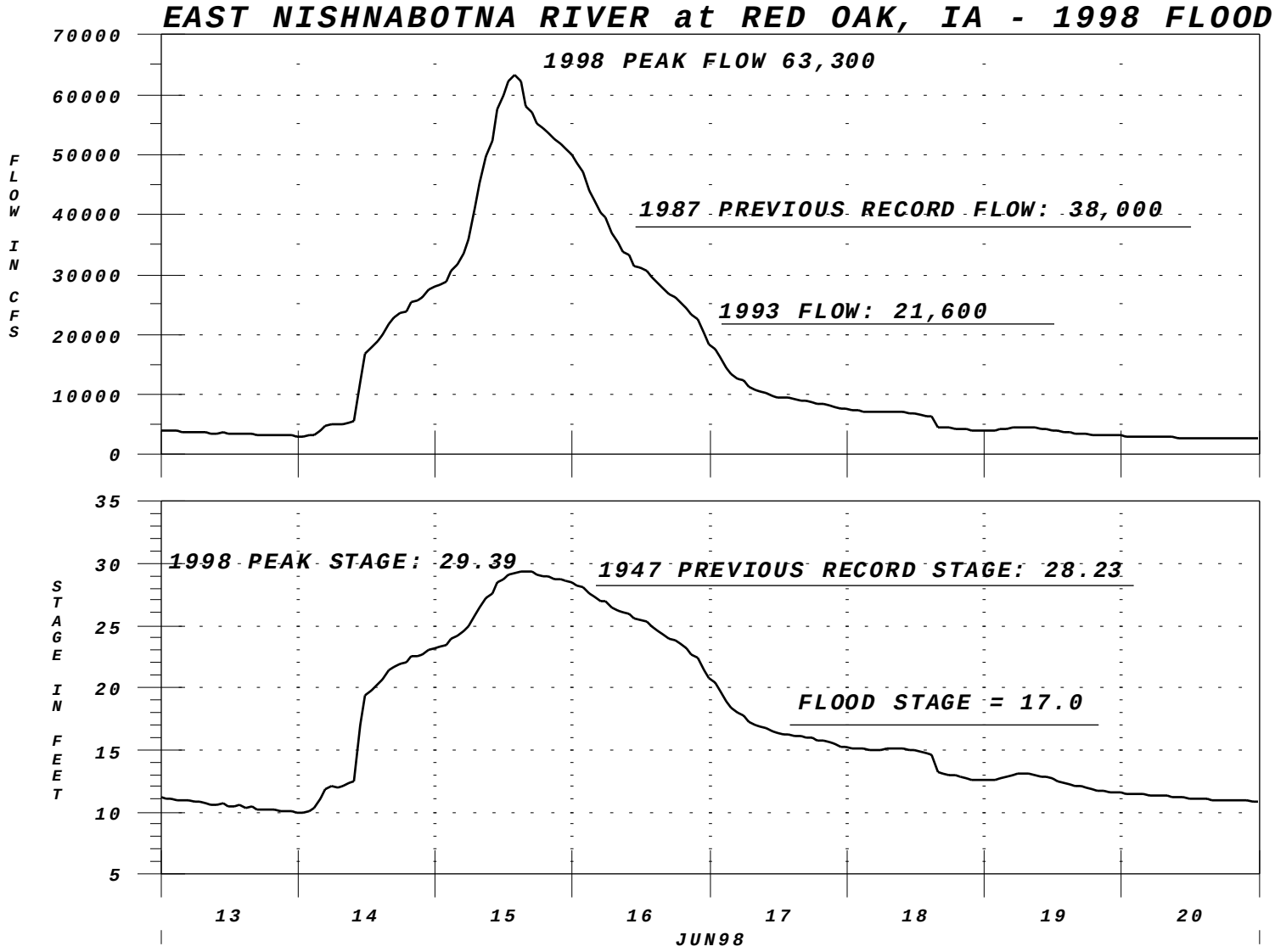
Figures 5-9 are the hydrographs for this event for the East Nishnabotna River at Atlantic and Red Oak, Iowa, West Nishnabotna River at Hancock and Randolph, Iowa, and Nishnabotna River at Hamburg, Iowa.



Prepared By:_____

Reviewed By:_____

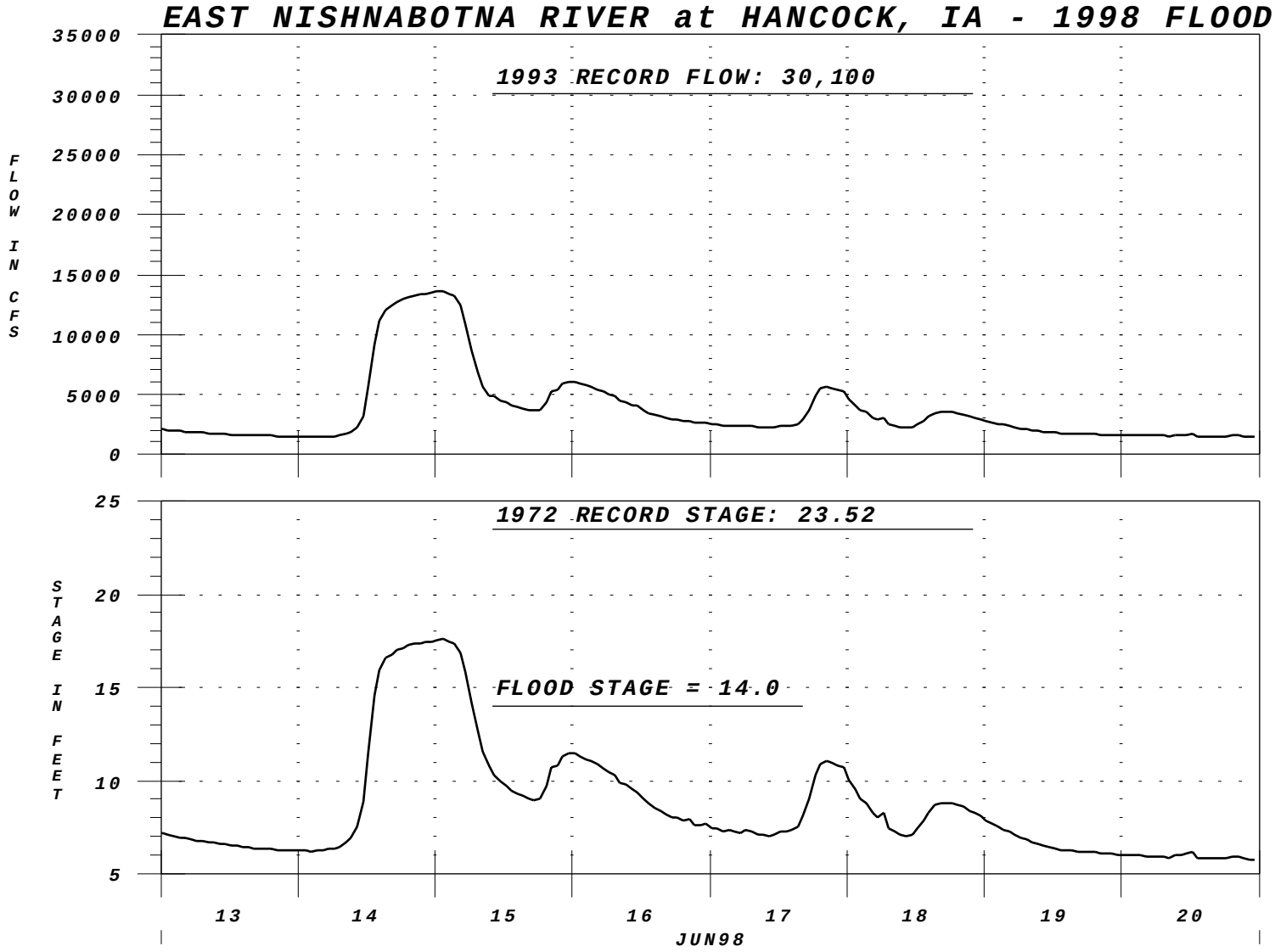
FIGURE 5



Prepared By:_____

Reviewed By:_____

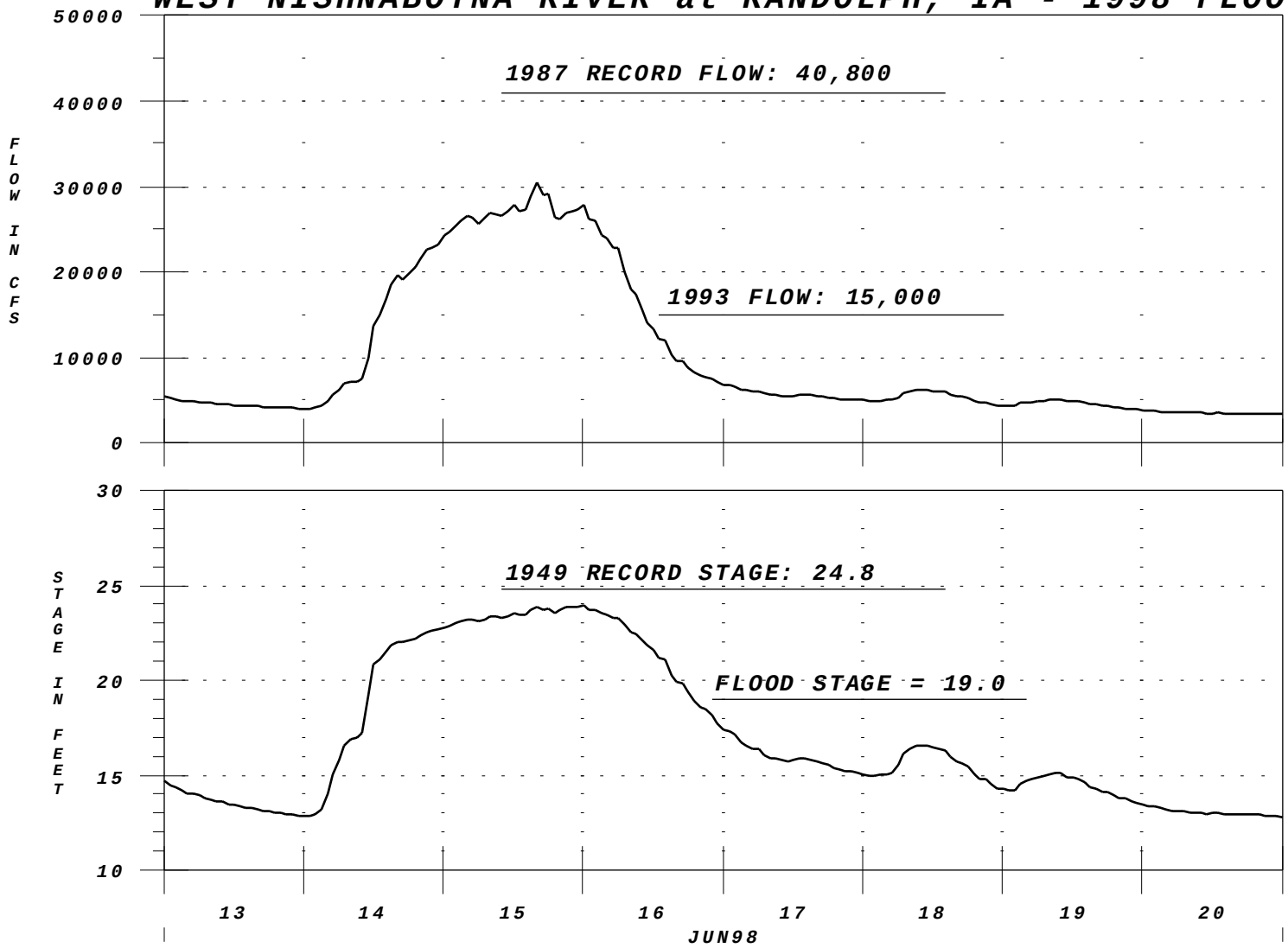
FIGURE 6



Prepared By:_____

Reviewed By:_____

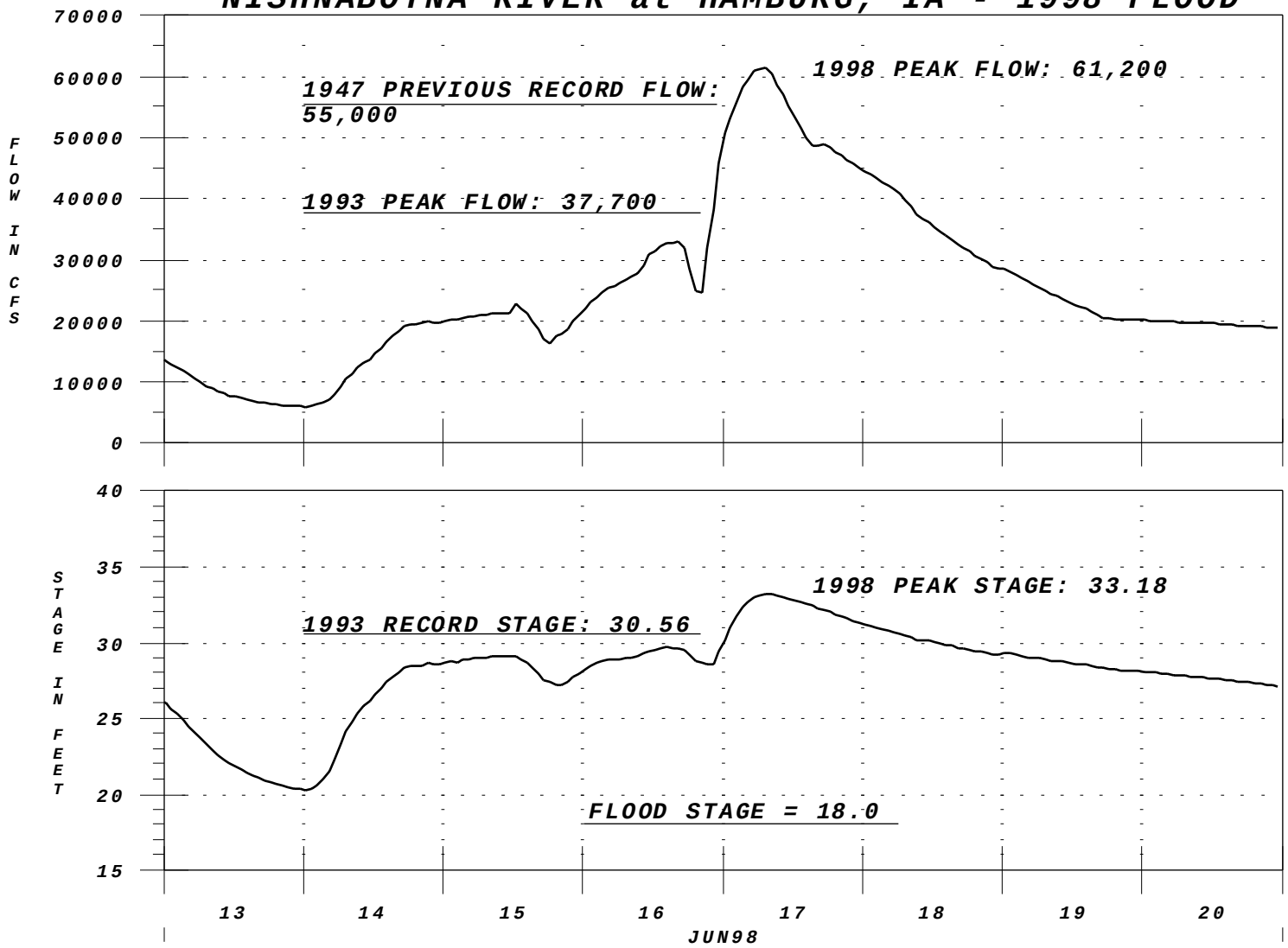
FIGURE 7



Prepared By:_____

Reviewed By:_____

FIGURE 8



Prepared By:_____

Reviewed By:_____

FIGURE 9

d. Runoff into Tributary Reservoirs. Although little flooding occurred during the report period, runoff was as high as 294 percent of normal and well above normal for all projects.

Table 5 lists runoff and peak pool statistics for tributary reservoir projects during the report period. Table 6 lists peak discharges at selected gaging stations including many reservoir release control points used by the Omaha District.

TABLE 5
RUNOFF AMOUNTS AND PEAK POOL LEVELS

NAME OF DAM	1998 (1) INFLOW ACRE-FEET	RECORD ANNUAL (1) INFLOW (ACRE-FEET)	AVERAGE INFLOW ACRE-FEET	1998 RUNOFF % OF NORMAL	1998 PEAK POOL	RECORD PEAK POOL (YEAR)
Bowman-Haley Dam	13,345	58,000 (72)	21,558	63	2754.85	2762.6 (78)
Bear Creek Dam	79,209	91,900 (83)	37,658	212	5567.21	5587.2 (95)
Chatfield Dam	177,010	450,000 (83)	162,896	108	5432.74	5447.6 (80)
Cherry Creek Dam	21,116	30,900 (84)	8,789	240	5552.00	5565.8 (73)
Cold Brook Dam	933	1,070 (94)	648	144	3585.42	3585.4 (94, 97)
Cottonwood Dam	n/a	n/a	n/a	n/a	n/a	n/a
Kelly Road Dam	n/a	n/a	n/a	n/a	n/a	n/a
Papio Dam 11	13,363	18,700 (80)	7,511	161	1123.87	1124.4 (84)
Papio Dam 16	3,491	3,310 (87)	1,187	271	1107.68	1107.8 (84)
Papio Dam 18	8,575	11,000 (93)	4,410	183	1112.96	1116.8 (93)
Papio Dam 20	4,536	9,710 (93)	4,245	182	1089.09	1103.2 (93)
Pipestem Dam	55,143	148,000 (97)	41,164	165	1457.76	1487.0 (97)
Salt Creek Dam 2	4,661	12,500 (87)	2,425	162	1336.15	1342.6 (93)
Salt Creek Dam 4	6,300	15,500 (93)	4,632	118	1309.42	1316.5 (73)
Salt Creek Dam 8	11,968	12,900 (97)	5,090	240	1288.24	1295.4 (73)
Salt Creek Dam 9	8,819	10,400 (87)	3,211	274	1273.79	1279.0 (73)
Salt Creek Dam 10	14,247	16,600 (93)	5,248	240	1247.84	1252.3 (73)
Salt Creek Dam 12	6,837	25,000 (84)	5,477	119	1236.27	1241.1 (87)
Salt Creek Dam 13	7,379	13,300 (93)	4,134	174	1344.65	1346.9 (83)

TABLE 5 (CONTINUED)

NAME OF DAM	1998 (1) INFLOW ACRE-FEET	RECORD ANNUAL (1) INFLOW (ACRE-FEET)	AVERAGE INFLOW ACRE-FEET	1998 RUNOFF % OF NORMAL	1998 PEAK POOL	RECORD PEAK POOL (YEAR)
Salt Creek Dam 14	9,693	23,300 (87)	8,066	113	1246.98	1249.9 (79)
Salt Creek Dam 17	9,443	11,100 (93)	3,034	294	1245.14	1250.0 (93)
Salt Creek Dam 18	33,335	74,400 (83)	29,413	110	1286.85	1287.9 (87)
Spring Creek Dam (Lake Pocasse)	n/a	n/a	n/a	n/a	1620.2	1625.0 (87)
Snake Creek Dam (Lake Audubon)	n/a	n/a	n/a	n/a	1847.2	1848.6 (76)
Westerly Creek Dam	n/a	n/a	n/a	n/a	n/a	n/a
BUREAU OF RECLAMATION						
Boysen Dam	1,399,230	1,476,000 (97)	1,015,693	147	4725.31	4730.8 (67)
Canyon Ferry Dam	5,005,053	5,786,000 (97)	3,890,750	128	3799.38	3800.0 (62)
Clark Canyon Dam	402,249	718,000 (84)	288,076	137	5551.08	5564.7 (84)
Glendo Dam	1,274,075	2,230,000 (84)	1,168,582	98	4633.64	4650.9 (73)
Heart Butte Dam	58,324	307,000 (82)	89,079	42	2066.37	2086.2 (52)
Jamestown Dam	67,553	211,400 (97)	36,297	208	1439.34	1445.7 (97)
Keyhole Dam	43,538	100,000 (78)	20,857	191	4098.20	4100.4 (78)
Pactola Dam	82,999	102,100 (97)	34,878	239	4584.76	4585.9 (65)
Shadehill Dam	37,029	284,000 (97)	64,900	65	2271.95	2297.9 (52)
Tiber Dam	428,435	1,150,000 (75)	633,872	71	2992.67	3005.6 (65)
Yellowtail Dam	2,787,920	3,516,000 (97)	2,493,178	114	3649.25	3656.4 (67)

(1) Water Year Oct 1 - Sep 30

TABLE 6
PROVISIONAL 1998 WATER YEAR PEAK STAGES AND DISCHARGES

Stream	Station	Drainage Area (Sq. Mi.)	Record Since	Flood Stage	Maximum 1998				Maximum Known		
					Date	Stage	Discharge (cfs)	Comments/ Alternate Date	Date	Stage	Discharge (cfs)
Red Rock River	below Lima Res, MT	570	1911	1.1	02 Jul 98	3.85	770		15 May 1993	5.40	2,500
Beaverhead River	nr Twin Bridges, MT	3,619	1935	5.2	29 Jun 98	6.79	1,150		12 May 1944	nr	3,130
Jefferson River	nr Three Forks, MT	9,532	1978	na	28 Jun 98	7.17	9,130	7.85 15 Dec 97	09 Jun 1995	9.00	17,000
Madison River	nr McAllister, MT	2,186	1901	4.4	27 Jun 98	6.83	6,590		12 Jun 1970	8.01	9,550
Gallatin River	@ Logan, MT	1,795	1893	7.5	26 Jun 98	8.30	6,410		21 Jun 1899	nr	9,840
Missouri River	@ Toston, MT	14,669	1890	10	27 Jun 98	9.94	21,600		12 Jun 1997	12.22	33,300
Missouri River	nr Ulm, MT	20,941	1957	13	05 Jul 98	13.04	23,100		01 Jun 1953	17.00	35,000
Sun River	nr Vaughn, MT	1,854	1897	10	04 Jul 98	6.13	3,680		09 Jun 1964	23.40	53,500
Missouri River	@ Virgelle, MT	34,379	1935	17	04 Jul 98	9.57	28,900		05 Jun 1953	23.40	122,000
Missouri River	nr Landusky, MT	40,987	1934	na	04 Jul 98	23.96	32,000		06 Jun 1953	nr	137,000
Milk River	@ Havre, MT	5,785	1899	10	14 May 98	4.60	1,240		12 Apr 1899	nr	20,000
Milk River	nr Saco, MT	17,670	1977	20	05 Jul 98	7.65	1,850		03 Apr 1979	24.20	12,400
Milk River	@ Nashua, MT	22,332	1939	20	08 Jul 98	11.68	4,270		18 Apr 1952	31.38	45,300
Missouri River	nr Wolf Point, MT	82,290	1928	10.9	09 Nov 97	7.27	24,500		25 Mar 1939	14.40	66,800
Missouri River	nr Culbertson, MT	91,557	1941	19	11 Nov 98	9.87	24,200		26 Mar 1943	15.12	78,200
Musselshell River	nr Roundup, MT	4,023	1946	5.1	23 Jun 98	3.85	784		18 Jun 1967	12.45	9,610
Yellowstone River	@ Billings, MT	11,795	1904	13	04 Jul 98	9.85	32,200		12 Jun 1997	15.00	82,000
Wind River	@ Riverton, WY	2,309	1906	8	04 Jul 98	9.25	6,160		15 Jun 1935	10.15	13,300

TABLE 6 (CONTINUED)

Stream	Station	Drainage Area (Sq. Mi.)	Record Since	Flood Stage	Maximum 1998				Maximum Known		
					Date	Stage	Discharge (cfs)	Comments/ Alternate Date	Date	Stage	Discharge (cfs)
Wind River	below Boysen Res, WY	7,701	1951	na	13 Aug 97	7.94	4,400		07 Jul 1967	13.35	13,500
Bighorn River	@ Kane, WY	15,765	1928	8	05 Jul 98	5.63	8,370	6.11 17 Dec 97	16 Jun 1935	11.10	25,200
Bighorn River	nr Bighorn, MT	22,414	1981	17	na	na	na		20 May 1978	nr	59,200
Yellowstone River	@ Miles City, MT	48,253	1922	13	06 Jul 98	9.19	39,800		22 May 1978	16.50	102,000
Tongue River	@ Miles City, MT	5,379	1938	5.8	24 Jun 98	4.60	1,250		15 Jun 1962	11.33	13,300
Powder River	nr Locate, MT	13,194	1938	8.4	na	na	na		19 Feb 1943	11.23	31,000
Yellowstone River	nr Sidney, MT	69,103	1910	19	07 Jul 98	12.44	44,300		21 Jun 1921	nr	159,000
Knife River	@ Hazen, ND	2,240	1928	12	23 Jun 98	5.80	666		24 Jun 1966	27.01	35,300
Missouri River	@ Bismarck, ND	186,400	1927	16	01 Aug 97	13.25	53,100		06 Apr 1952	27.90	500,000
Heart River	nr Mandan, ND	3,310	1924	17	29 Mar 98	4.61	1,200		19 Apr 1950	23.64	30,500
Cannonball River	@ Breien, ND	4,100	1934	10	25 Jun 98	6.62	1,480		19 Apr 1950	22.30	94,800
N Fork Grand River	@ Haley, ND	509	1908	17	-------	---	---	Disc. 30 Sep 1995	07 Apr 1952	17.03	14,100
Grand River	@ Little Eagle, SD	5,370	1958	15	12 Jul 98	9.53	2,590	10.14 22 Mar 98(1)	23 Mar 1987	19.16	31,000
Moreau River	nr Whitehorse, SD	4,880	1954	21	23 Jun 98	12.29	5,970		23 Mar 1997	27.01	30,000
Belle Fourche River	@ WY-SD State Line	3,280	1946	14	07 Jul 98	8.66	908		18 Jun 1962	15.59	4,400
Fall River	@ Hot Springs, SD	137	1937	13	20 May 98	3.14	107		04 Sep 1938	18.40	13,100
Rapid Creek	@ Rapid City, SD	410	1942	7	13 Sep 97	7.76	1,260		09 Jun 1972	19.66	50,000
Cheyenne River	nr Plainview, SD	23,900	1960	14	20 Jun 98	17.01	22,200		22 May 1982	15.77	55,900
Bad River	nr Ft. Pierre, SD	3,107	1928	21	26 Jul 98	11.76	4,250		01 Jul 1905	32.90	70,000
Niobrara River	nr Verdel, NE	12,600	1958	12	26 Jun 98	4.00	5,560	5.60 25 Jan 98	27 Mar 1960	10.10	39,000

TABLE 6 (CONTINUED)

Stream	Station	Drainage Area (Sq. Mi.)	Record Since	Flood Stage	Maximum 1998				Maximum Known		
					Date	Stage	Discharge (cfs)	Comments/ Alternate Date	Date	Stage	Discharge (cfs)
Vermillion River	nr Vermillion, SD	2,302	1983	21	27 Apr 98	14.60	2,460		23 Jun 1984	31.77	21,400
Pipestem Creek	nr Pingree, ND	700	1973	10	29 Mar 98	9.93	1,300		20 Apr 1979	11.60	2,520
James River	nr Grace City, ND	1,060	1968	12	31 Mar 98	9.96	1,730	10.52 30 Mar 98	28 Jul 1993	13.82	3,786
James River	@ Jamestown, ND	2,820	1928	12	01 Sep 97	11.48	1,730		13 May 1950	15.82	6,390
James River	@ Lamoure, ND	4,390	1957	14	28 Mar 98	11.32	2,470		14 Apr 1969	16.17	6,800
James River	@ Columbia, SD	7,393	1988	11	15 Apr 98	14.41	1,230		18 Apr 1997	19.02	5,000
James River	@ Ashton, SD	9,742	1945	13	03 Aug 97	13.67	1,650		08 Apr 1997	25.85	8,330
James River	nr Scotland, SD	20,653	1928	13	04 Jun 98	13.68	3,940		23 Jun 1984	20.45	29,400
Big Sioux River	nr Watertown, SD	1,007	1972	6.8	17 May 98	8.87	1,140	9.19 26 Feb 98	06 Apr 1997	12.05	7,680
Big Sioux River	nr Dell Rapids, SD	4,483	1948	12	08 Apr 98	9.29	2,470		09 Apr 1969	16.47	41,300
Skunk Creek	@ Sioux Falls, SD	622	1948	na	08 Apr 98	2.82	742		17 Jun 1957	nr	29,400
Big Sioux River	@ Sioux Falls, SD	5,216	1962	16	09 Apr 98	12.27	3,220		10 Apr 1969	27.45	40,700
Rock River	nr Rock Valley, IA	1,592	1948	16	29 Mar 98	8.69	2,450		07 Apr 1969	17.32	40,400
Big Sioux River	@ Akron, IA	8,424	1928	16	10 Apr 98	15.93	7,170		09 Apr 1969	22.99	80,800
Missouri River	@ Sioux City, IA	314,600	1897	36	01 Nov 97	22.65	73,600	23.24 13 Oct 97	14 Apr 1952	24.28	441,000
Perry Creek	@ Sioux City, IA	65	1945	15.5	30 May 98	13.18	1,490		19 May 1990	28.54	8,670
Floyd River	@ Alton, IA	268	1955	12	16 Apr 98	7.48	356		20 Jun 1983	18.54	16,300
Floyd River	@ James, IA	886	1934	26	26 Apr 98	13.36	1670		08 Jun 1953	25.30	71,500
Missouri River	@ Decatur, NE	316,200	1987	23.2	27 Nov 97	28.30	74,700	30.28 07 Nov 97	16 Jul 1993	32.04	75,400
Little Sioux River	@ Linn Grove, IA	1,548	1927	20	02 Jul 98	10.27	2,080		02 Jul 1993	20.69	17,399

TABLE 6 (CONTINUED)

Stream	Station	Drainage Area (Sq. Mi.)	Record Since	Flood Stage	Maximum 1998				Maximum Known		
					Date	Stage	Discharge (cfs)	Comments/ Alternate Date	Date	Stage	Discharge (cfs)
Little Sioux River	@ Correctionville, IA	2,500	1918	19	16 Jun 98	9.85	3,120		07 Apr 1965	25.86	29,800
West Fork Ditch	@ Hornick, IA	403	1939	20	24 Jun 98	14.40	1,770		28 Mar 1962	22.46	12,400
Little Sioux River	nr Turin, IA	3,526	1958	20	24 Jun 98	19.08	10,900		21 Jun 1983	26.54	31,200
Maple River	@ Mapleton, IA	669	1941	16	24 Jun 98	10.76	8,590		12 Sep 1978	16.74	20,800
Soldier River	@ Pisgah, IA	407	1940	28	06 Jul 98	13.65	5,530		12 Jun 1950	28.17	22,500
Boyer River	@ Logan, IA	871	1918	19	11 Jun 98	14.45	9,690		17 Jun 1990	22.54	30,800
Missouri River	@ Omaha, NE	322,800	1928	29	27 Oct 97	23.48	79,800	24.13 14 Oct 97	18 Apr 1952	40.20	396,000
Missouri River	@ Nebraska City, NE	410,000	1929	18	15 Jun 98	20.34	97,300		19 Apr 1952	27.66	414,000
West Nishnabotna River	@ Hancock, IA	609	1959	14	15 Jun 98	17.53	15,000		02 Apr 1993	24.76	29,257
West Nishnabotna River	@ Randolph, IA	1,326	1948	19	15 Jun 98	23.92	35,000		26 May 1987	24.50	40,800
East Nishnabotna River	nr Atlantic, IA	436	1960	17	15 Jun 98	22.36	41,400		12 Sep 1972	22.81	26,700
East Nishnabotna River	@ Red Oak, IA	894	1918	18	15 Jun 98	29.39	60,500		13 Sep 1972	27.43	38,000
Nishnabotna River	above Hamburg, IA	2,806	1922	36	17 Jun 98	33.18	65,100		24 Jun 1947	26.03	55,500
Missouri River	@ Rulo, NE	414,900	1949	17	16 Jun 98	22.27	133,000		22 Apr 1952	25.60	358,000
North Platte River	nr Sinclair, WY	4,175	1939	19	18 Jun 98	7.49	7,010		11 Jun 1986	11.30	16,200
North Platte River	nr Glenrock, WY	13,538	1959	4.5	26 Apr 98	3.58	3,242		14 May 1965	7.10	16,000
North Platte River	below Walen Res, WY	16,425	1909	4.5	05 Apr 98	7.95	3,670		26 Jun 1955	9.85	22,000
Laramie River	nr Ft. Laramie, WY	4,564	1915	na	05 Jan 98	2.26	97		10 May 1973	9.40	6,260
North Platte River	@ WY-NE State Line	22,218	1929	4.5	02 Apr 98	4.77	3,940		02 Jun 1929	nr	17,900
North Platte River	@ Bridgeport, NE	25,300	1905	8	na	na	na		26 Jun 1899	5.39	24,900

TABLE 6 (CONTINUED)

Stream	Station	Drainage Area (Sq. Mi.)	Record Since	Flood Stage	Maximum 1998				Maximum Known		
					Date	Stage	Discharge (cfs)	Comments/ Alternate Date	Date	Stage	Discharge (cfs)
North Platte River	@ Lewellen, NE	28,600	1937	7	15 Mar 98	7.34	4,260	8.34 03 Mar 98	04 Jun 1971	nr	13,500
North Platte River	@ North Platte, NE	30,900	1895	7	26 Jul 98	5.84	2,440		11 Jun 1909	nr	29,600
South Platte River	nr Hartsel, CO	880	1933	na	30 Jul 98	3.78	792		27 Apr 1970	7.60	3,970
South Platte River	@ Waterton, CO	2,621	1928	6	21 Jul 98	2.82	1,366		23 Apr 1942	5.68	5,700
N. Fk South Platte River	@ Grant, CO	127	1908	na	01 Jul 98	1.99	740		07 Jun 1912	nr	990
Bear Creek	@ Sheridan, CO	260	1914	8	25 Jul 98	5.73	1,510		07 May 1969	10.50	8,150
Bear Creek	@ Morrison, CO	164	1887	7.5	07 May 98	6.40	1,117		24 Jul 1896	nr	8,600
South Platte River	@ Denver, CO	3,861	1889	9	25 Jul 98	10.90	13,551		17 Jun 1965	18.66	40,300
Clear Creek	@ Golden, CO	400	1974	7	04 Jun 98	6.93	1,000		10 Jul 1983	6.44	2,370
Clear Creek	@ Derby, CO	575	1916	8	05 May 98	3.54	1,614		24 Jul 1965	8.97	5,070
South Platte River	@ Henderson, CO	4,713	1926	11	26 Jul 98	8.99	9,590		06 May 1973	11.67	33,000
South Platte River	nr Kersey, CO	9,598	1901	10	07 Aug 97	8.28	9,270		08 May 1973	11.73	31,500
South Platte River	@ Julesburg, CO	23,193	1902	10	01 Aug 97	6.99	5,680		20 Jun 1965	10.44	37,600
South Platte River	@ North Platte, NE	24,300	1897	12	12 Aug 97	8.38	3,300	12.43 11 Jan 98	03 Jun 1935	14.02	37,100
Platte River	@ Brady, NE	56,200	1935	5	na	na	na		29 Jun 1983	nr	23,500
Platte River	nr Kearney, NE	58,200	1982	6	07 Apr 98	4.92	5,610		29 Jun 1983	7.42	23,700
Platte River	nr Grand Island, NE	58,800	1933	4	08 Apr 98	3.93	8,750		06 Jun 1935	5.99	30,000
Middle Loup River	@ St. Paul, NE	8,090	1894	8	15 Jun 98	4.22	6,220		23 Jun 1947	nr	72,000
North Loup River	@ St. Paul, NE	4,290	1894	5.5	18 Jun 98	5.15	7,940		06 Jun 1896	nr	90,000
Elkhorn River	@ Norfolk, NE	2,790	1945	10	16 Jun 98	9.53	9,090		14 Jun 1967	8.52	16,900

TABLE 6 (CONTINUED)

Stream	Station	Drainage Area (Sq. Mi.)	Record Since	Flood Stage	Maximum 1998				Maximum Known		
					Date	Stage	Discharge (cfs)	Comments/ Alternate Date	Date	Stage	Discharge (cfs)
Elkhorn River	@ West Point, NE	5,100	1940	12	18 Jun 98	10.89	9,920		09 Mar 1993	19.30	90,658
Elkhorn River	@ Waterloo, NE	6,900	1928	17	06 Jul 98	13.56	26,300		12 Jun 1944	16.60	100,000
Platte River	@ North Bend, NE	77,100	1949	8	19 Jun 98	6.92	28,000		29 Mar 1960	10.04	112,000
Platte River	@ Louisville, NE	85,800	1953	9	14 Jun 98	8.27	51,300		24 Jul 1993	12.12	164,231
Logan Creek	nr Uehling, NE	1,030	1941	16	05 Jul 98	13.01	5,330		20 Feb 1971	20.15	25,200
Salt Creek	@ Lincoln, NE	648	1940	20.5	14 Jun 98	18.61	15,300		19 Jul 1986	18.24	8,000
Salt Creek	@ Greenwood, NE	1,051	1951	20	15 Jun 98	18.59	19,600		13 Jun 1984	26.50	46,800
Little Papillion Creek	@ Irvington, NE	32	1948	17	14 Jun 98	9.49	873		03 Jun 1943	23.00	nr
Big Papillion Creek	@ Fort Street, NE	126	1966	na	05 Jul 98	38.54	25,824		17 Feb 1966	30.51	nr
Papillion Creek	@ Fort Crook, NE	384	1948	29	na	na	na		21 May 1982	30.68	12,700

(1) Grand River at Little Eagle gage was lowered 4.0 feet, new datum set at 1624.63 msl.

V. RESERVOIR ACCOMPLISHMENTS.

a. Flood Damages Prevented. Flood damages prevented in FY98 by Corps of Engineers Mainstem Reservoirs, Tributary reservoirs and local protection projects, and Bureau of Reclamation projects are summarized in Table 7. Table 7 also shows cumulative totals of flood damages prevented for each of the projects. Flood damages prevented in each state are shown in Table 8.

b. Recreation Usage. Visitation hours for each Corps of Engineers project for FY95, FY96, FY97, and FY98 are tabulated in Table 9**.**

TABLE 7
FLOOD DAMAGES PREVENTED FY98 -LOCAL AND MAIN STEM REDUCTIONS

Omaha District Projects	Location	Cumulative Thru FY 97 ($1,000)	MARCH ($1,000)	APRIL ($1,000)	MAY ($1,000)	JUNE ($1,000)	JULY ($1,000)	SEPT ($1,000)	Total FY 1998 ($1,000)	Cumulative Thru FY 98 ($1,000)
Missouri River Reservoirs	MRO	2,253,813				13,198	16,868		30,066	2,283,879
Other Reservoir Projects										
Aurora Dam/D.S. Chanl. Impr.	CO	7,413							0	7,413
Bear Creek Dam	CO	2,137							0	2,137
Bowman-Haley Dam	ND/SD	6,506							0	6,506
Chatfield Dam	CO	5,553							0	5,553
Cottonwood Springs Dam	SD	0							0	0
Cherry Creek Dam	CO	163,442							0	163,442
Cold Brook Dam	SD	0							0	0
Papillion Creek Dams/Chnl. Im.	NE	11,879							0	11,879
Pipestem Dam	ND	34,175							0	34,175
Salt Creek Dams/Levees	NE	82,963				186			186	83,149
Subtotal:		314,068				186			186	314,254
Missouri River Levee System										
L-601	IA	101,400				2,938	1,517		4,455	105,855
L-594	IA	71,983				2,077	1,073		3,150	75,133
L-575	IA/MO	80,901				1,688	103		1,791	82,692

TABLE 7 (CONTINUED)

Omaha District Projects	Location	Cumulative Thru FY 97 ($1,000)	MARCH ($1,000)	APRIL ($1,000)	MAY ($1,000)	JUNE ($1,000)	JULY ($1,000)	SEPT ($1,000)	Total FY 1998 ($1,000)	Cumulative Thru FY 98 ($1,000)
L-561/L-550	MO	63,799				1,442	88		1,530	65,329
L-536	MO	18,455				395	24		419	18,874
R-613	NE	22,112				646	333		979	23,091
R-573	NE	3,407				73	4		77	3,484
R-562	NE	9,893				226	14		240	10,133
R-548	NE	7,374				157	10		167	7,541
R-520	NE	2,085				48	3		51	2,136
Subtotal:		381,409				9,690	3,169		12,859	394,268
Local Protection Projects										
Belle Fourche R. @ B. F.	SD	380							0	380
Big Sioux R. @ Sioux City	IA	5,520							0	5,520
Blackbird Creek @ Macy	NE	552				158			158	710
Broken Bow, Mud Creek	NE	150							0	150
Clarkson, Maple Ck.	NE	2,642							0	2,642
Columbus, Loup River	NE	16,018							0	16,018
Council Bluffs, Missouri R.	IA	619,449							0	619,449
Deadman Gulch @ Sturgis	SD	5,792							0	5,792
Emerson, Indian Creek	IA	0				2,311			2,311	2,311

TABLE 7 (CONTINUED)

Omaha District Projects	Location	Cumulative Thru FY 97 ($1,000)	MARCH ($1,000)	APRIL ($1,000)	MAY ($1,000)	JUNE ($1,000)	JULY ($1,000)	SEPT ($1,000)	Total FY 1998 ($1,000)	Cumulative Thru FY 98 ($1,000)
Floyd River @ Sioux City	IA	30,399							0	30,399
Forsyth, Yellowstone R.	MT	4,165							0	4,165
Gering Valley	NE	1,784							0	1,784
Glasgow, Milk R.	MT	1,345							0	1,345
Great Falls, Sun R.	MT	10							0	10
Greybull, Bighorn R.	WY	9,156							0	9,156
Hamburg, Nishabotna R.	IA	132,287				50,928	64		50,992	183,279
Havre, Milk R.	MT	47,624							0	47,624
Hawarden, Dry Creek	IA	552							0	552
Herreid, Spring Creek	SD	33							0	33
Hooper, Elkhorn R.	NE	3,875					134		134	4,009
Hot Springs, Fall R.	SD	0							0	0
Howells, E. Fork of Maple Ck.	NE	1,200							0	1,200
Ida Grove, Maple R.	IA	1,660				217			217	1,877
Kenslers Bend	SD/NE	39,068						914	914	39,982
Little Papillion Ck. @ Omaha	NE	4,476							0	4,476
Little Sioux River	IA	175,058				1,621	4		1,625	176,683
Lodgepole Ck. @ Sidney	NE	31,200							0	31,200

TABLE 7 (CONTINUED)

Omaha District Projects	Location	Cumulative Thru FY 97 ($1,000)	MARCH ($1,000)	APRIL ($1,000)	MAY ($1,000)	JUNE ($1,000)	JULY ($1,000)	SEPT ($1,000)	Total FY 1998 ($1,000)	Cumulative Thru FY 98 ($1,000)
Lost Creek @ Columbus	NE	3							0	3
Madison, Union/Taylor Cks.	NE	4,791				220			220	5,011
Mandan, Heart R.	ND	37,085						182	182	37,267
Marmarth, Little Missouri R.	ND	1,449							0	1,449
Meadow Grove, Buffalo Ck.	NE	734							0	734
Norfolk, Elkhorn River	NE	34,132				1,653			1,653	35,785
Omaha, Missouri River	NE	690,429							0	690,429
Pebble Ck. @ Scribner	NE	17,929							0	17,929
Pierce, N. F. Elkhorn R.	NE	999							0	999
Platte R. @ Schuyler	NE	2,587				36			36	2,623
Red Dale Gulch	SD	250							0	250
Red Oak, E. Nishnabotna R.	IA	12,837	26	5		12,613	158		12,802	25,639
Saco, Beaver Ck.	MT	1,211							0	1,211
Schuyler, Lost Ck.	NE	394							0	394
Scranton, Buffalo Ck.	ND	0							0	0
Scribner, Elkhorn R.	NE	512							0	512
Sheridan, Goose Ck.	WY	1,504							0	1,504
Shields R. @ Clyde Park	MT	156							0	156

TABLE 7 (CONTINUED)

Omaha District Projects	Location	Cumulative Thru FY 97 ($1,000)	MARCH ($1,000)	APRIL ($1,000)	MAY ($1,000)	JUNE ($1,000)	JULY ($1,000)	SEPT ($1,000)	Total FY 1998 ($1,000)	Cumulative Thru FY 98 ($1,000)
Sioux Falls, Big Sioux R.	SD	18,869	26	1					27	18,896
Vaughn, Sun R.	MT	485							0	485
Waterloo, Elkhorn R.	NE	470							0	470
W. Glendive, Yellowstone R.	MT	15,073							0	15,073
West Point, Elkhorn R.	NE	17,209							0	17,209
Subtotal:		1,993,503	52	6		69,757	360	1,096	71,271	2,064,774
Other Projects										
McCook Lake	SD	0							0	0
Total Corps Projects:	MRO	4,942,793	52	6	0	92,831	20,397	1,096	114,382	5,057,175

TABLE 7 (CONTINUED)

River Basin	Bureau of Reclamation Projects/ Omaha District	Reach Location	Cumulative Thru FY97 ($1,000)	MARCH ($1,000)	APRIL ($1,000)	MAY ($1,000)	JUNE ($1,000)	JULY ($1,000)	SEPT ($1,000)	Total FY98 ($1,000)	Cumulative Thru FY98 ($1,000)
Big Horn River	Boysen	WY	69,445				761	1,847		2,608	72,053
	Buffalo Bill	WY	7,804				178			178	7,982
	Bull Lake	WY	2,601							0	2,601
	Yellowtail	MT	85,687				1,682	2,997		4,679	90,366
	Subtotal:		165,536				2,620	4,844		7,464	173,000
Cheyenne River	Angostura	SD	21							0	21
	Keyhole	WY/SD	3,546				7			7	3,553
	Pactola	SD	2,529				382			382	2,911
	Subtotal:		6,096				389			389	6,485
Grand River	Shadehill	SD	8,828				46			46	8,874
Heart River	Heart Butte	ND	13,101							0	13,101
James River	Jamestown	ND	74,521			600				600	75,121
Marias River	Tiber	MT	52,814				1,398	521		1,919	54,733
Milk River	Fresno	MT	10,773					49		49	10,822
Missouri River	Canyon Ferry	MT	121,198				2,734	2,113		4,847	126,045
North Platte River	Pathfinder	WY	8,392				24			24	8,416

TABLE 7 (CONTINUED)

River Basin	Bureau of Reclamation Projects/ Omaha District	Reach Location	Cumulative Thru FY97 ($1,000)	MARCH ($1,000)	APRIL ($1,000)	MAY ($1,000)	JUNE ($1,000)	JULY ($1,000)	SEPT ($1,000)	Total FY98 ($1,000)	Cumulative Thru FY98 ($1,000)
	Alcova	WY	401				24			24	425
	Seminoe	WY	24,024				153			153	24,177
	Guernsey	WY	439							0	439
	Glendo	WY/NE	49,566				3,488			3,488	53,054
	Subtotal:		82,822				3,688			3,688	86,510
Sun River	Gibson	MT	3,042							0	3,042
Threeforks Basin	Clark Canyon	MT	11,190				134	180		314	11,504
Total Bureau Projects:			549,921	0	0	600	11,010	7,705	0	19,315	569,236

TABLE 8
FY98 FLOOD DAMAGES PREVENTED, OMAHA DISTRICT

State	Main Stem Dams ($1,000)	Main Stem Urban Levees ($1,000)	Main Stem Non-Urban Levees ($1,000)	Bureau of Reclamation Dams (Main Stem) ($1,000)	Bureau of Reclamation Dams (Local) ($1,000)	Corps Local Protection Dams ($1,000)	Corps Local Protection Levees ($1,000)	Corps Supported Emergency Operations ($1,000)	TOTAL ($1,000)
Colorado	0	0	0	0	0	0	0	0	0
Iowa	5,018	0	9,199	0	0	0	67,947	10,567	92,731
Missouri	3,457	0	2,146	0	0	0	0	797	6,400
Montana	0	0	0	11,117	690	0	0	0	11,807
Nebraska	8,476	0	1,513	0	2,790	186	2,658	77	15,700
N. Dakota	13,115	0	0	0	600	0	182	0	13,897
S. Dakota	0	0	0	92	339	0	484	0	915
Wyoming	0	0	0	2,600	1,088	0	0	0	3,688
TOTAL	30,066	0	12,858	13,809	5,507	186	71,271	11,441	145,138

TABLE 9

RECREATION VISITATION IN HOURS				
PROJECT NAME	**FY95**	**FY96**	**FY97**	**FY98**
Bowman-Haley	210,700	332,800	300,400	269,900
Cottonwood Springs	203,500	234,900	135,600	135,600
Cold Brook	70,100	79,800	63,500	63,500
Pipestem	285,000	150,000	153,100	155,200
Papillion Creek #11	464,800	627,900	616,100	451,100
Papillion Creek #16	215,500	238,600	162,400	184,600
Papillion Creek #18	749,300	838,300	822,600	841,000
Papillion Creek #20	609,400	548,400	544,800	634,700
Papillion Creek Total	**2,039,000**	**2,253,200**	**2,145,900**	**2,111,400**
Chatfield	4,654,600	5,641,800	4,977,600	4,939,600
Cherry Creek	8,551,700	8,505,300	7,950,000	8,029,500
Bear Creek	641,600	895,300	957,700	1,150,200
Tri-Lakes Total	**13,847,900**	**15,042,400**	**13,885,300**	**14,119,300**
Salt Creek #2	91,600	86,600	74,600	77,500
Salt Creek #4	110,100	104,500	110,200	114,400
Salt Creek #8	100,800	93,300	95,300	83,000
Salt Creek #9	90,500	79,000	111,300	190,000
Salt Creek #10	44,000	48,700	34,900	44,300
Salt Creek #12	302,100	244,100	165,100	198,900
Salt Creek #13	26,900	36,800	48,300	38,100
Salt Creek #14	1,282,300	922,100	679,500	683,300
Salt Creek #17	1,360,900	1,159,000	1,150,500	930,600
Salt Creek #18	1,594,600	1,618,300	1,103,900	1,123,000
Salt Creek Total	**5,003,800**	**4,392,400**	**3,573,600**	**3,483,100**
TOTAL	**21,660,000**	**22,485,500**	**19,299,700**	**20,338,000**

VI. RESERVOIR OPERATION. Actual operations for the past year and proposed operations through calendar year 1998 are discussed briefly in the following subsections. Individual project operation summaries are contained in Appendix 1 for Corps of Engineers projects and Bureau of Reclamation projects. Table 10 summarizes the tributary reservoir flood control operation for 1998. A tabulation of the number of cases that the exclusive flood control zones in the 36 Omaha District tributary reservoirs have been filled to 25, 50, 75, and 100 percent is shown on Table 11.

TABLE 10
TRIBUTARY RESERVOIR FLOOD CONTROL OPERATION (1998 WATER YEAR)

Name of Dam	Flood Control Pool (Ft Msl)	Date in Flood Control Operation Pool	Daily Maximum Pool (Ft Msl)	Date of Maximum Pool	Maximum Daily Storage in FC Pool Acre Feet (1)	Maximum % of FC Pool Occupied	Maximum Inflow CFS	Maximum Outflow CFS
COE Reservoirs								
Bear Creek	5558.0	All Year	5567.2	09 May	1,147	4	658	512
Bowman-Haley	2754.8	April	2754.9	09 Apr	88	< 1	390	94
Bull Hook	2517.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cedar Canyon	3526.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Chatfield	5432.0	Intermittent	5432.7	07 Jun	1,070	< 1	1,467	1,484
Cherry Creek	5550.0	All Year	5552.2	05 Aug	1,890	2	394	80
Cold Brook	3585.0	All Year	3585.4	13 Jun	15	< 1	4	3
Cottonwood	3936.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Kelly Road	5342.0	All Year	5349.2	11 Aug	38	11	n/a	n/a
Papio No. 11	1121.0	April –September	1123.9	15 Jun	1,192	9	391	114
Papio No. 16	1104.0	All Year	1107.7	06 Jul	520	14	191	48
Papio No. 18	1110.0	October –July	1113.0	05 Jul	833	11	419	86
Papio No. 20	1095.8	All Year	1098.1	14 Jun	569	9	267	57
Pipestem	1442.5	All Year	1457.8	12 Apr	19,701	15	1,134	357
Salt Ck No. 2	1335.0	Intermittent	1336.2	27 Mar	596	15	131	45
Salt Ck No. 4	1307.4	Intermittent	1309.4	14 Jun	670	9	290	75
Salt Ck No. 8	1287.8	June	1287.7	14 Jun	418	6	440	85
Salt Ck No. 9	1271.1	November –July	1273.8	08 Apr	1,077	24	276	70

TABLE 10 (CONTINUED)

Name of Dam	Flood Control Pool (Ft Msl)	Date in Flood Control Operation Pool	Daily Maximum Pool (Ft Msl)	Date of Maximum Pool	Maximum Daily Storage in FC Pool Acre Feet (1)	Maximum % of FC Pool Occupied	Maximum Inflow CFS	Maximum Outflow CFS
Salt Ck No. 10	1244.9	Dec. –Sept.	1247.8	14 Jun	786	13	211	71
Salt Ck No. 12	1232.9	December –June	1236.3	14 Jun	1,568	20	406	115
Salt Ck No. 13	1341.0	April –August	1344.7	14 Jun	1,711	34	539	162
Salt Ck No. 14	1244.3	April –August	1247.0	14 Jun	2,130	10	884	260
Salt Ck No. 17	1242.4	Nov. –Sept.	1245.1	14 Jun	500	9	179	82
Salt Ck No. 18	1284.0	December –July	1286.9	15 Jun	5,527	8	1,945	430
Westerly Creek	5389.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a
USBR Reservoirs								
Boysen	4725.0	July	4725.3	09 Jul	7,798	5	9,411	6,176
Canyon Ferry	3797.0	June-July	3799.4	30 Jun	78,694	79	23,294	20,222
Clark Canyon	5546.1	July	5551.1	09 Jul	26,341	33	1,531	1,257
Glendo	4635.0	None	4633.6	16 Jun	0	0	4,237	7,646
Heart Butte	2064.5	June –September	2066.4	22 Jun	811	< 1	3,025	1,175
Jamestown	1429.8	Jan. –Sept.	1439.3	14 Apr	30,650	17	1,856	399
Keyhole	4099.3	None	4098.2	04 Apr	0	0	876	149
Pactola	4580.2	June –July	4584.8	23 Jun	4,009	9	1,009	438
Shadehill	2271.9	July	2272.0	11 Jul	0	0	1,036	160
Tiber	2993.0	None	2992.7	09 Jul	0	0	3,413	1,118
Yellowtail	3640.0	July –September	3649.3	10 Aug	33,981	13	13,999	7,109

(1) If a project has a joint use pool, storage in the joint use zone is not counted as flood control in this table.

TABLE 11

UTILIZATION OF EXCLUSIVE FLOOD STORAGE ZONE
OMAHA DISTRICT TRIBUTARY PROJECTS

Percent of Flood Control Storage

Year	Total of Tributary Projects	25% or More	50% or More	75% or More	100% or More
1967	26	3	2	2	0
1968	27	0	0	0	0
1969	27	1	0	0	0
1970	28	2	2	0	0
1971	28	2	1	0	0
1972	28	1	0	0	0
1973	28	6	2	1	0
1974	31	1	1	0	0
1975	32	6	2	1	1
1976	32	2	1	0	0
1977	32	0	0	0	0
1978	33	5	1	0	0
1979	33	1	0	0	0
1980	33	2	1	0	0
1981	33	2	1	1	0
1982	33	2	1	0	0
1983	34	5	1	1	0
1984	35	7	2	1	1
1985	35	0	0	0	0

TABLE 11 (CONTINUED)

UTILIZATION OF EXCLUSIVE FLOOD STORAGE ZONE
OMAHA DISTRICT TRIBUTARY PROJECTS

Percent of Flood Control Storage

Year	Total of Tributary Projects	25% or More	50% or More	75% or More	100% or More
1986	35	5	0	0	0
1987	35	3	0	0	0
1988	35	0	0	0	0
1989	35	0	0	0	0
1990	36	0	0	0	0
1991	36	2	1	0	0
1992	36	0	0	0	0
1993	36	12	0	0	0
1994	36	2	0	0	0
1995	36	6	3	0	0
1996	36	6	1	0	0
1997	36	6	3	0	0
1998	36	3	1	1	0
TOTAL		**93**	**27**	**8**	**2**

NOTE: Number of tributary projects excludes Spring Creek and Snake Creek Dams because they do not have flood control storage.

a. Previous Years Operation (August 1, 1997 through July 31, 1998).

(1) Corps of Engineers Lakes. All Corps' tributary projects within the Omaha District were regulated in accordance with normal procedures during the period covered by this report. As shown on Table 10 all of the tributary projects including Bear Creek, Bowman-Haley, Chatfield, Cherry Creek, Cold Brook, Papillion Creek Dams #11, #16, #18,#20, Pipestem, Salt Creek Dams #2, #4, #8, #9, #10, #12, #13, #14, #17, and #18, stored water in the flood storage zone or

above their normal level at some time during the report period. Although there were no major floods, most projects had above normal inflows over the report period.

(a) Tri-Lakes Flood Control Operation. No downstream flooding was reported.

Cherry Creek Reservoir flood control operations were insignificant during the report period, and reservoir elevations only fluctuated between 5550.0 and 5551.2 feet msl. Chatfield Reservoir reached the flood control pool intermittently from April through June. Bear Creek Reservoir was operated to pass inflows up to 500 cfs (normal operations) and all inflows were effectively passed in a reasonable period of time.

Snow pack equivalents for the South Platte River basin near the Tri-Lakes are shown in Table 12.

TABLE 12

South Platte River Basin Snow Water Equivalent on May 1 (inches)			
South Platte River basin	**1997**	**1998**	**Ave. 1961-90**
Sundance	13.6	11.0	6.8
Geneva Park	4.0	3.7	1.8
Antero	0.3	0	0.5
Weston	1.0	0	0.7
Horseshoe Mountain	17.2	10.6	10.4
Mosquito Creek	14.3	9.2	6.4
Como	7.6	6.7	4.9
Hoosier Pass (Snotel)	27.5	16.5	13.8
Loveland Basin (Snotel)	29.4	19.6	16.0
Clear Creek basin			
Empire	11.9	10.6	7.3
Berthoud Falls	17.5	14.2	11.8
Berthoud Summit(Snotel)	30.6	9.6	19.7

*Four new stations were added in 1998. One in the Bear Creek basin and three in

the upper South Platte River basin. These stations will be utilized in making snowmelt runoff forecasts.

(b) Cherry Creek Reservoir, Colorado Normal Operations. On April 1, 1988, the State of Colorado, through the State Engineer, implemented strict administration of water rights within the Cherry Creek basin. When a senior river call is in effect, the Cherry Creek Reservoir is required to pass inflow through the project. Releases from the project were coordinated by the Hydrology and Water Control Section to comply with downstream river calls as determined by the Colorado State Engineers office. A total of 18 release orders were made during the report period. The releases were made to meet downstream water needs, and to maintain the conservation pool level. Due to scheduled gate maintenance, the annual sediment flushing exercise was not accomplished this year. The flush is scheduled for next year.

(c) Papillion Creek Basin, Nebraska. Minor low-level releases were made at Papillion Creek Reservoir #18, Zorinsky Lake, to lower pool level to facilitate fish habitat. See summary in Section VI.

(d) Salt Creek Basin, Nebraska. Minor releases were made from Salt Creek Reservoir #12, Conestoga, during the late summer to facilitate fish habitat as requested by the Nebraska Game and Parks Commission. The Nebraska Game and Parks Commission has scheduled renovation at Salt Creek Reservoirs #2, Olive Creek, and #8, Wagon Train for the coming winter. Releases have been made to lower the lake to the low level gate inverts and the Nebraska Game and Parks has installed siphon tubes at both reservoirs to lower lake levels an additional 5 to 10 feet. Shoreline protection, sediment detention, and possible outlet modification are planned for both projects. Salt Creek Reservoir #18 was lowered 5 feet to facilitate shoreline protection work. The reservoir will be maintained at this level until the work is completed sometime in early spring.

(e) Bowman-Haley, North Dakota. Releases were made from March to May to allow inflows to pass through the reservoir.

(f) Pipestem, North Dakota. The 1998 snowmelt began with warming temperatures bringing an initial melt of the small amount of snow in the James River on February 22, 1998. On February 27th the NWS issued a spring flood outlook stating that most of the snow in the James River Valley had melted and that no flooding was expected under current conditions. The Omaha District Water Control Office was forecasting a normal runoff year for the first time since the July 1993 rainfall event.

Warm temperatures brought a second round of snowmelt beginning

March 22nd. The NWS issued a spring flood outlook on March 27th once again stating that no flooding was expected. However the trace amount of remaining snow in the basin brought a surprising amount of inflow into the reservoirs. The factors largely responsible for the unanticipated volume of runoff were saturated soils and groundwater seepage into the rivers. The magnitude of flows was not exceptionally high but the duration of the flows was longer than expected. From the beginning of the melt, February 22nd, to the end of the melt, May 1st, Jamestown Reservoir received approximately 55,500 acre-feet of runoff. This represents around 0.8 inches of runoff over a drainage area of 1300 square miles. For this same period, Pipestem Reservoir received approximately 36,600 acre-feet of runoff. Over a drainage area of 594 square miles this represents around 1.2 inches of runoff. Pipestem always produces more runoff per unit of drainage area than does Jamestown. This is a result of steeper drainage gradients in Pipestem's drainage basin. Jamestown's drainage is considerably flatter. This is a large amount of runoff when the water equivalency of the snow pack was at the most in the 1 to 2 inch range.

An updated forecast presented at a James River operations meeting on April 7th indicated runoff would be approximately 180% of normal and the Jamestown pool would rise to a level very close to the 1440 ft-msl elevation that would require a release of 750 cfs. At the April 7th meeting alternative operating plans were discussed including a high early release followed by a low constant release. There was no strong preference concerning the release schedule, so releases were made according to the 1975 Field Working Agreement (FWA).

A release of 450 cfs as indicated in the 1975 FWA was made on April 1st after the James River at Lamoure, North Dakota, crested on March 28th and the downstream channel was clear of ice. This release was maintained until July 10th when both flood pools were completely evacuated and releases were reduced. A deviation was granted on May 29th to allow Pipestem releases to be increased to 350 cfs and Jamestown releases to be reduced to 100 cfs. This deviation was to lower the Pipestem pool elevation, facilitating construction of a relief well outflow network below the dam. The deviation lasted only a week before it was agreed to postpone the Pipestem contract until the drier fall months.

Table 13 presents a chronology of the 1998 operation of Jamestown and Pipestem Dams. Figures 10 through 12 represent graphical summaries of reservoir conditions during the 1998 runoff. Figure 13 shows the actual vs. unregulated annual flow of the James River at the Jamestown gage for 1998. Figure 14 represents the historical annual flow of the James River at the Jamestown gage.

TABLE 13
1998 JAMESTOWN AND PIPESTEM RESERVOIR RELEASES
(PERIOD 01/JAN/1998 TO 10/JUL/1998)

		Pipestem					Jamestown				
	Time	Elevation	Gate Settings (feet)			Release	Elevation	Gate Settings (feet)		Release	Combined
Date	Hours	(ft, msl)	36" Low Level	4'x7' East	4'x7' West	(cfs)	(ft, msl)	No. 2	No. 4	(cfs)	Release (cfs)
1-Jan	0100	1442.9	0.00	0.00	1.70	25	1429.1	0.00	0.00	0	25
		Pipestem's west service gate was left open 1.7 feet to pass inflow over the winter (approximately 25 cfs), letting what flowed over the service spillway control the release. Normally the gate is set at 0.7 feet to limit releases to 100 cfs in the event of a sudden pool rise in the spring. However to offset gate settlement that normally occurs over the winter months, the gate was set at the larger opening.									
14-Jan	1200	1442.7	0.00	0.00	1.40	15	1429.1	0.00	0.00	0	15
		Pipestem's west service gate had settled to 1.4 feet.									
14-Feb	1200	1442.8	0.00	0.00	1.00	20	1429.2	0.00	0.00	0	20
		Pipestem's west service gate had settled to 1.0 feet.									
22-Feb		First round of snowmelt begins and Pipestem pool begins to climb for the first time.									
23-Feb	2400	1443.7	0.00	0.00	1.00	130	1429.5	0.00	0.00	0	130
		Snowmelt runoff began on February 21. No gate adjustment was made. However with the rising Pipestem pool, the regulation of the project transitioned from weir control at the service spillway to orifice control at the gate opening (1.0 feet) resulting in a discharge of 130 cfs.									
27-Feb	1200	1447.5	0.00	0.00	0.70	100	1430.5	0.00	0.00	0	100
		The Pipestem west gate was reduced to 100 cfs to follow 1975 Field Working Agreement (FWA), Table 1.									

TABLE 13 (CONTINUED)

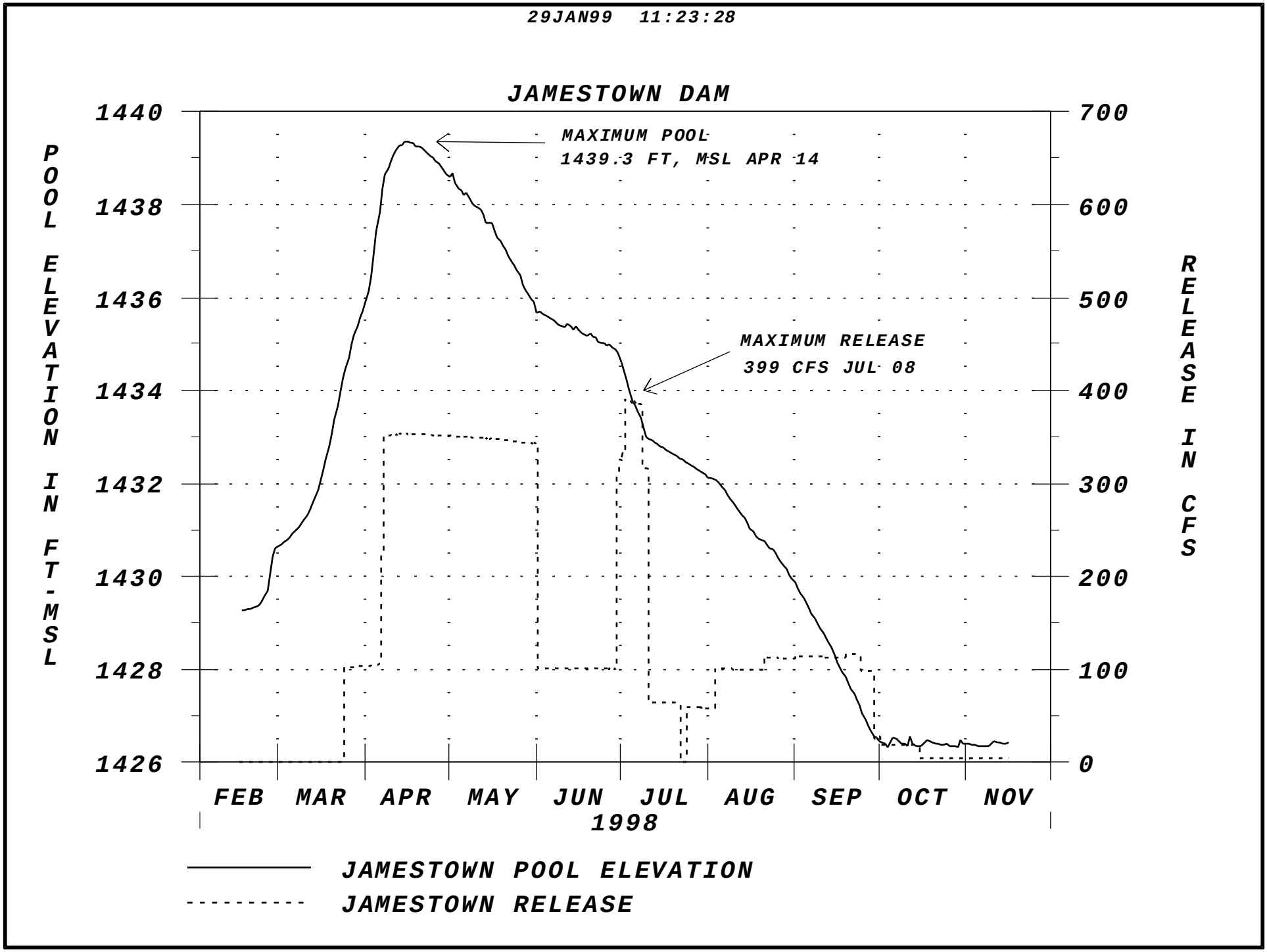
Date	Time Hours	Pipestem Elevation (ft, msl)	Pipestem Gate Settings (feet) 36" Low Level	Pipestem Gate Settings (feet) 4'x7' East	Pipestem Gate Settings (feet) 4'x7' West	Pipestem Release (cfs)	Jamestown Elevation (ft, msl)	Jamestown Gate Settings (feet) No. 2	Jamestown Gate Settings (feet) No. 4	Jamestown Release (cfs)	Combined Release (cfs)
1-Mar	LaMoure crests for the first time at a stage of 10.9 feet and a discharge of 2,300 cfs.										
4-Mar	An informational meeting was conducted with the City of Jamestown and the public.										
18-Mar	The Jamestown pool entered the flood control zone (1432.67 feet, msl) at 1400 hours.										
22-Mar	Second round of snowmelt begins and Pipestem pool begins to climb a second time.										
24-Mar	0700	1449.7	0.00	0.00	0.70	100	1434.3	0.00	0.00	100	200
	A release was initiated out of Jamestown Reservoir as storage increased in the flood pool.										
28-Mar	LaMoure crests for the second time at a stage of 11.2 feet and a discharge of 2,500 cfs.										
30-Mar	1200	1455.4	0.00	0.00	1.25	200	1435.6	0.00	0.00	100	300
	A combined release of 450 cfs was targeted per the 1975 FWA, 350 cfs from Pipestem and 100 cfs from Jamestown. Setting Pipestem releases higher than Jamestown releases was in response to a request by Operations Division to draw Pipestem pool down to conservation pool as quickly as was resonably possible in order to reduce groundwater levels below the dam and to have as dry an area as possible to construct a drain system for relief wells. Operations would like to get the contactor started in May.										
31-Mar	1230	1456.2	0.00	0.00	1.90	300	1435.8	0.00	0.00	100	400
	Pipestem releases were increased to 300 cfs - See comment for 30-March.										
1-Apr	1315	1456.7	0.00	0.00	2.20	350	1436.0	0.00	0.00	100	450
	Pipestem releases were increased to 350 cfs - See comment for 30-March.										

TABLE 13 (CONTINUED)

Date	Time Hours	Pipestem Elevation (ft, msl)	Pipestem Gate Settings (feet) 36" Low Level	Pipestem Gate Settings (feet) 4'x7' East	Pipestem Gate Settings (feet) 4'x7' West	Pipestem Release (cfs)	Jamestown Elevation (ft, msl)	Jamestown Gate Settings (feet) No. 2	Jamestown Gate Settings (feet) No. 4	Jamestown Release (cfs)	Combined Release (cfs)
6-Apr	0900	1457.1	0.00	0.00	1.40	225					
	1700						1438.2	0.00	1.20	225	450
		Releases were transitioned over to Jamestown Reservoir due to two main factors;(1) a revised April 5 forecast that indicated much higher runoff than was earlier forecasted with Jamestown pool approaching elevation 1440 ft, msl and (2) geotech agreed to postpone the Pipestem contract until the drier fall months.									
7-Apr		James River opeations meeting was held in Jamestown between th COE, USBR, USFWS and other agencies. The plan of releasing 450 cfs combined for approximately 3 months followed by a 100 cfs release until November was presented. No one at the meeting vocalized any disagreement with this plan.									
7-Apr	0900	1457.2	0.00	0.00	0.60	100					
	1500						1438.6	0.00	1.88	350	450
		See the comment for 6-Apr. The 450 cfs combined release with 100 cfs from Pipestem and 350 cfs from Jamestown									
12-Apr		Pipestem pool crests at elevation 1457.76 ft,msl.									
14-Apr		Jamestown pool crests at elevation1439.34 ft,msl.									
7-May	0730	1456.9	0.00	0.00	0.00	0	1438.2	0.00	1.88	350	350
	1215	1456.9	0.00	0.00	0.60	100	1438.1	0.00	1.88	350	450
		Pipestem shutdown for inspection of outlet works.									

TABLE 13 (CONTINUED)

Date	Time Hours	Pipestem Elevation (ft, msl)	Pipestem Gate Settings (feet) 36" Low Level	Pipestem Gate Settings (feet) 4'x7' East	Pipestem Gate Settings (feet) 4'x7' West	Pipestem Release (cfs)	Jamestown Elevation (ft, msl)	Jamestown Gate Settings (feet) No. 2	Jamestown Gate Settings (feet) No. 4	Jamestown Release (cfs)	Combined Release (cfs)
1-Jun	1000						1435.6	0.00	0.50	100	
	1015	1455	0.00	0.00	2.25	350					450
		Releases increased at Pipestem to draw pool down to top of conservation pool by July 1. This will lower the water table below the dam facilitating the construction of a toe drain relief well collection system.									
29-Jun	1115	1443.5	0.00	0.00	2.25	95	1434.9	0.00	1.70	310	405
		Jamestown releases increased as Pipestem discharge drops off due to falling pool targeting 450 cfs combined.									
30-Jun	1200	1443.3	0.00	0.00	2.25	80	1434.7	0.00	1.80	325	405
		See 29 June comment									
1-Jul	1000	1443.3	0.00	0.00	2.25	70	1434.5	0.00	1.85	335	405
		See 29 June comment									
2-Jul	1100	1443.2	0.00	0.00	2.25	65	1434.3	0.00	2.20	390	455
		See 29 June comment									
8-Jul	1800	1443.6	0.00	0.00	2.25	110	1433.3	0.00	1.80	315	425
		Jamestown release decreased in response to flooding in the ND/SD stateline area and the need to pump approximately 30 cfs at the Oakes Test Site into the James River.									
10-Jul	1000	1443.4	0.50	0.00	2.25	120					
	1600						1432.8	0.00	0.30	50	170
		Jamestown releases reduced as pool level nears base of flood control pool (1432.67 ft,msl). Lowlevel gate opened to 30 cfs at Pipestem to discharge poor quality bottom water.									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MAXIMUM POOL
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MAXIMUM RELEASE
399 CFS JUL 08
POOL ELEVATION IN FT-MSL
RELEASE IN CFS
1440
1438
1436
1434
1432
1430
1428
1426
700
600
500
400
300
200
100
0
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
1998
JAMESTOWN POOL ELEVATION
JAMESTOWN RELEASE

FIGURE 10

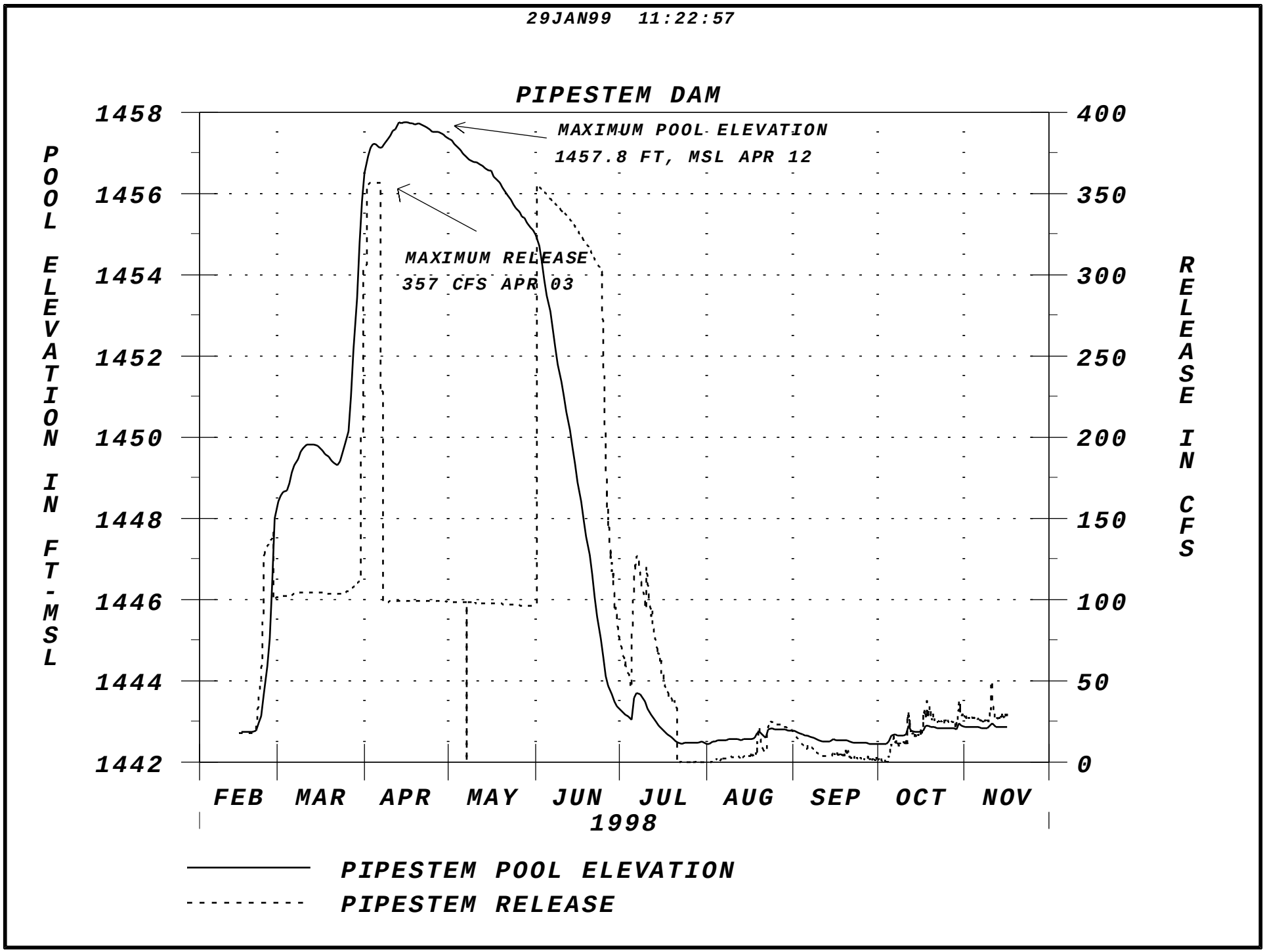

29JAN99 11:22:57
PIPESTEM DAM
MAXIMUM POOL ELEVATION
1457.8 FT, MSL APR 12
MAXIMUM RELEASE
357 CFS APR 03
POOL ELEVATION IN FT-MSL
RELEASE IN CFS
1458
1456
1454
1452
1450
1448
1446
1444
1442
400
350
300
250
200
150
100
50
0
FEB MAR APR MAY JUN JUL AUG SEP OCT NOV
1998
PIPESTEM POOL ELEVATION
PIPESTEM RELEASE

FIGURE 11

29JAN99 10:53:31

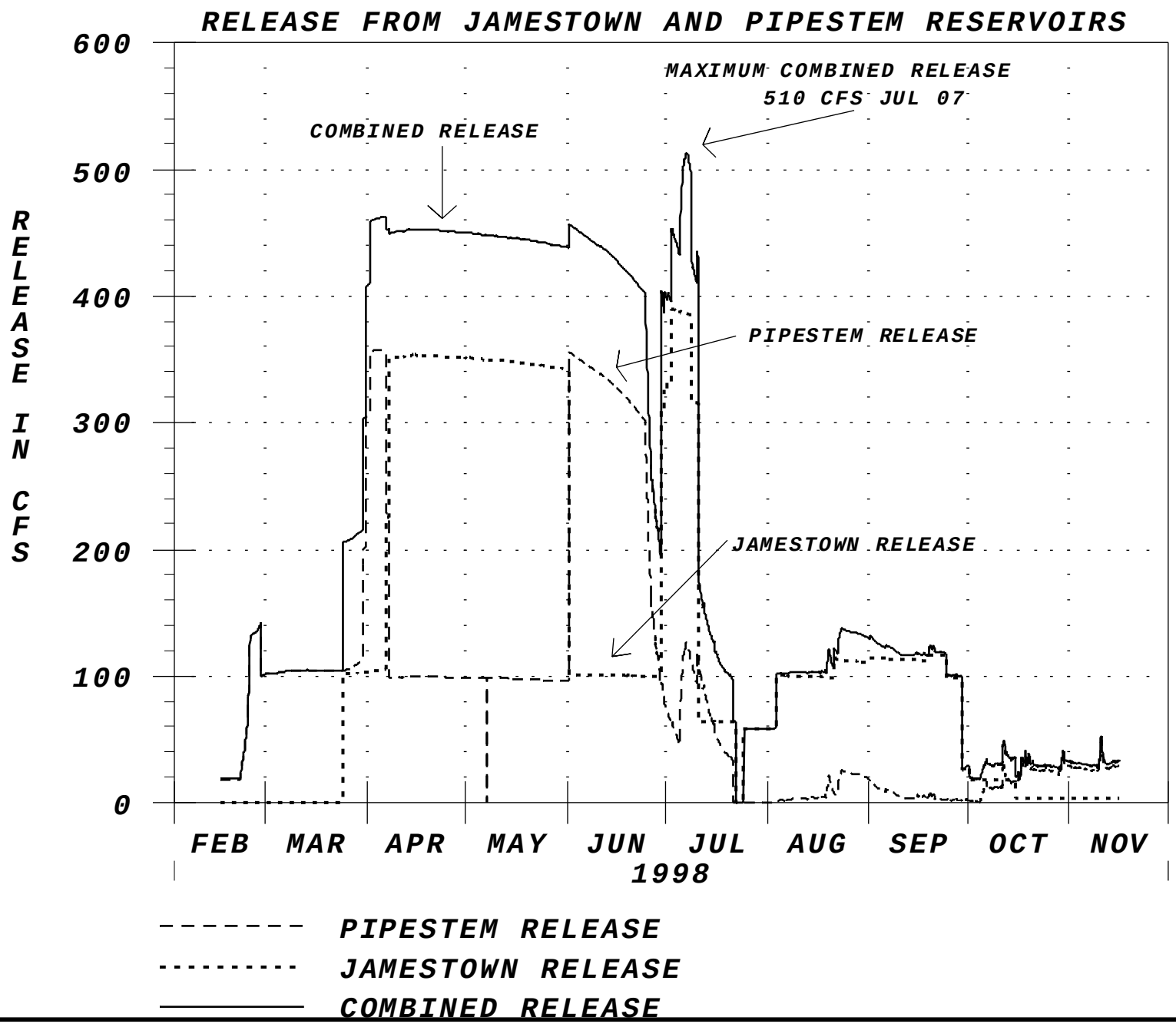


FIGURE 12

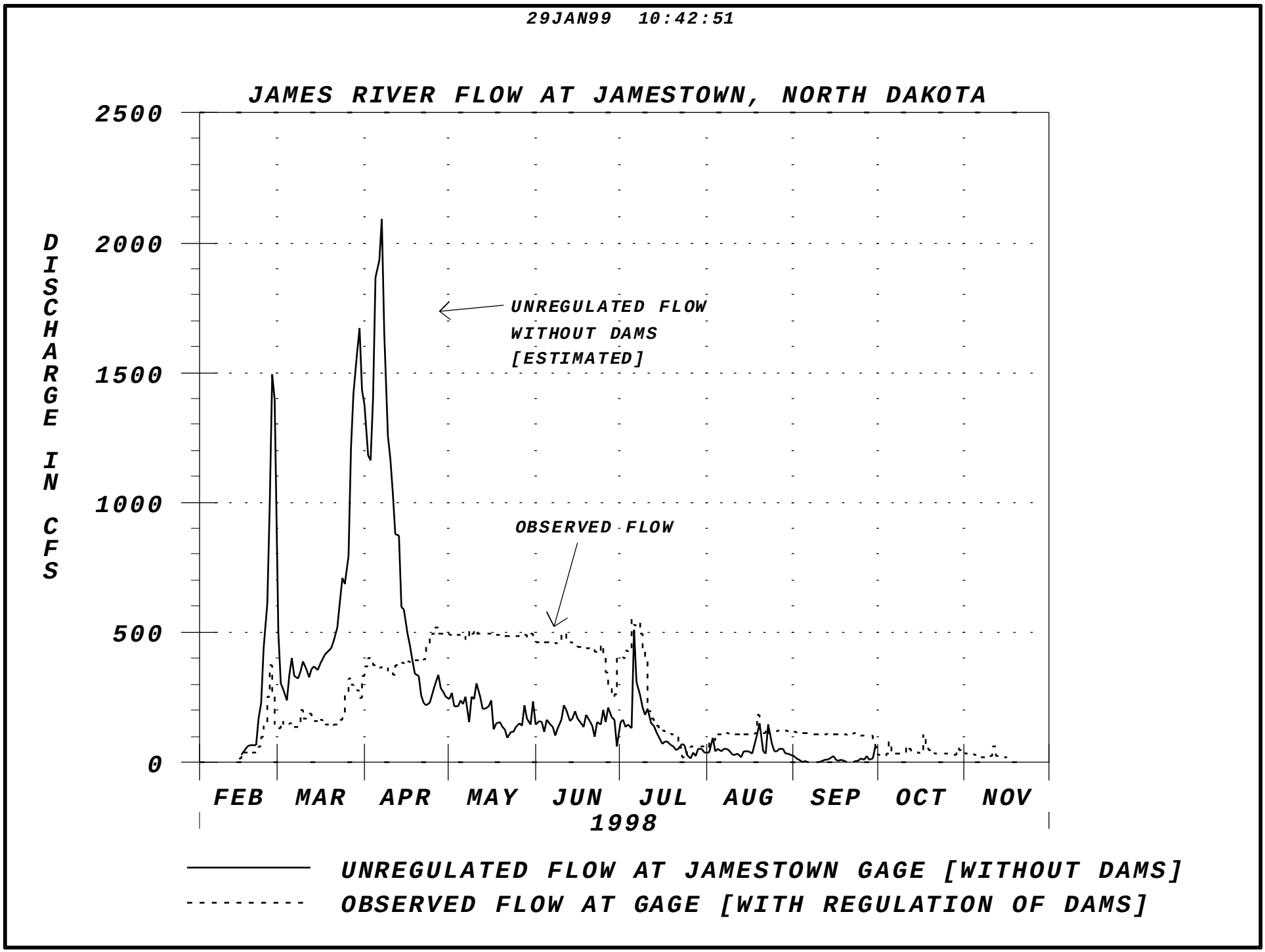

29JAN99 10:42:51
JAMES RIVER FLOW AT JAMESTOWN, NORTH DAKOTA
DISCHARGE IN CFS
2500
2000
1500
1000
500
0
UNREGULATED FLOW
WITHOUT DAMS
[ESTIMATED]
OBSERVED FLOW
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
1998
UNREGULATED FLOW AT JAMESTOWN GAGE [WITHOUT DAMS]
OBSERVED FLOW AT GAGE [WITH REGULATION OF DAMS]

FIGURE 13

HISTORICAL ANNUAL FLOW AT JAMES RIVER GAGE AT JAMESTOWN, ND

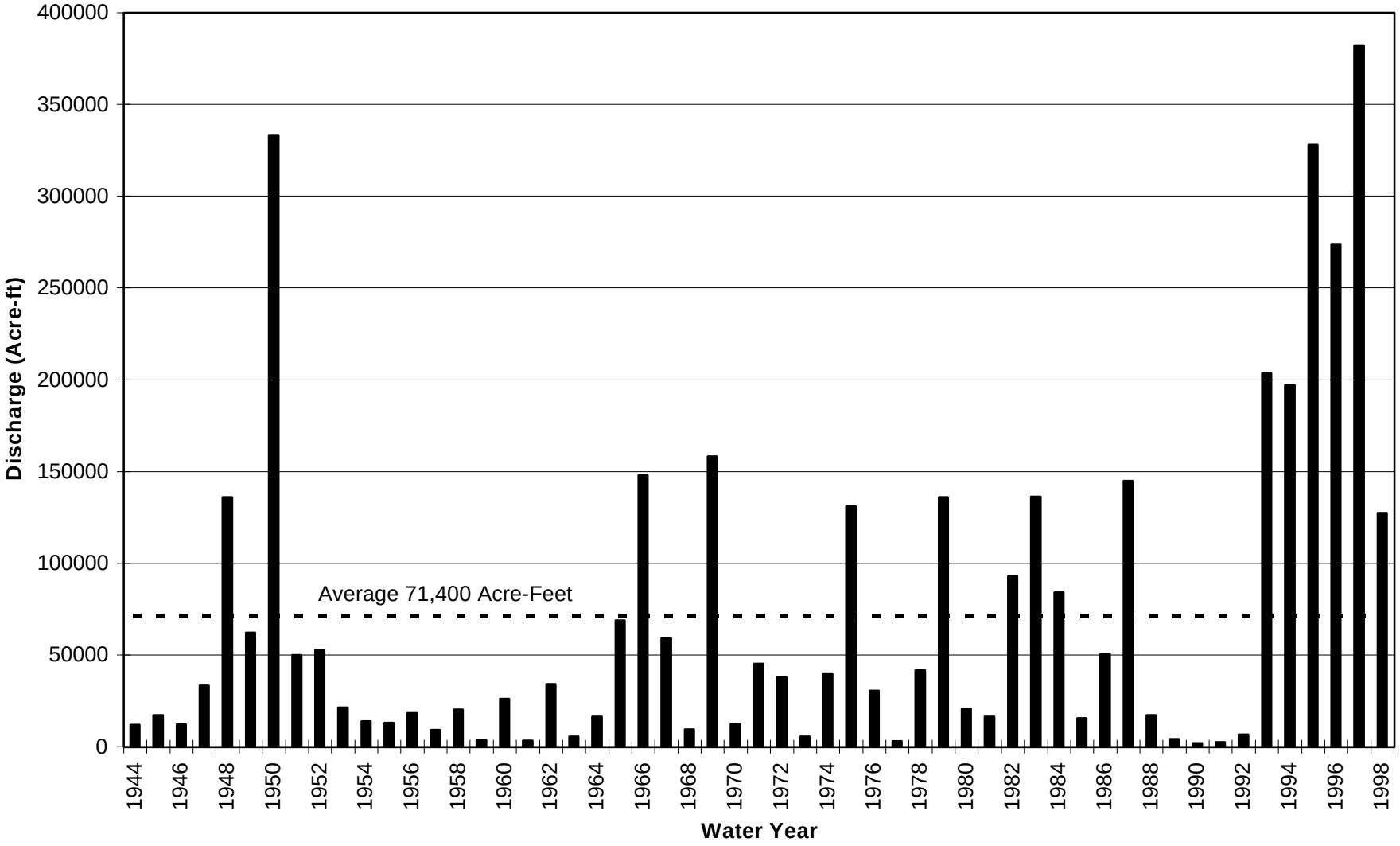


FIGURE 14

(2) Bureau of Reclamation Dams. Reservoir operations at the 11 Bureau of Reclamation projects in the Omaha District were carried out in accordance with normal regulation procedures during the period covered by this report. Seven of the eleven Section 7 projects stored water in the flood control zone. (See Table 10.)

(a) Canyon Ferry Dam, Montana. Despite the average snow pack (see Figure 15) and below average forecasted inflow, a combination of high elevation snowmelt and steady rainfall resulted in a surprisingly large inflow into Canyon Ferry. As shown on Figure 16 the Missouri River stage at Ulm, Montana, reached 13.0 feet as a result of Canyon Ferry releases of over 20,000 cfs. No reports of flooding were received at this stage. The National Weather Service lists the flood stage at Ulm at 13.0 feet. However the damaging discharge at Ulm is listed at 25,000 cfs in the Field Working Agreement and discharges can approach 30,000 cfs without causing excessive damage. Flows at Ulm in 1997 during last year's operation reached 28,900 cfs without serious damage.

The peak pool elevation of 3799.38 ft-msl on June 30, 1998, is the third highest of record since the Corps and the USBR signed a Field Working Agreement in 1966 stipulating the regulation of Canyon Ferry for flood control. It was exceeded only in 1975 and 1981 when the pool reached elevations 3797.9 and 3799.7 feet, msl, respectively. The pool reached such a high level this year because releases were kept at a low level. This was a result of two factors: (1) the runoff was caused by low intensity, long duration rainfall in combination with melting of the remaining high elevation snow pack which was fairly predictable and non-threatening so encroachment into the flood pool was not considered excessively risky; and (2) the desire to keep downstream stages low allowing for possible runoff from evening thundershowers.

29JAN99 11:25:25

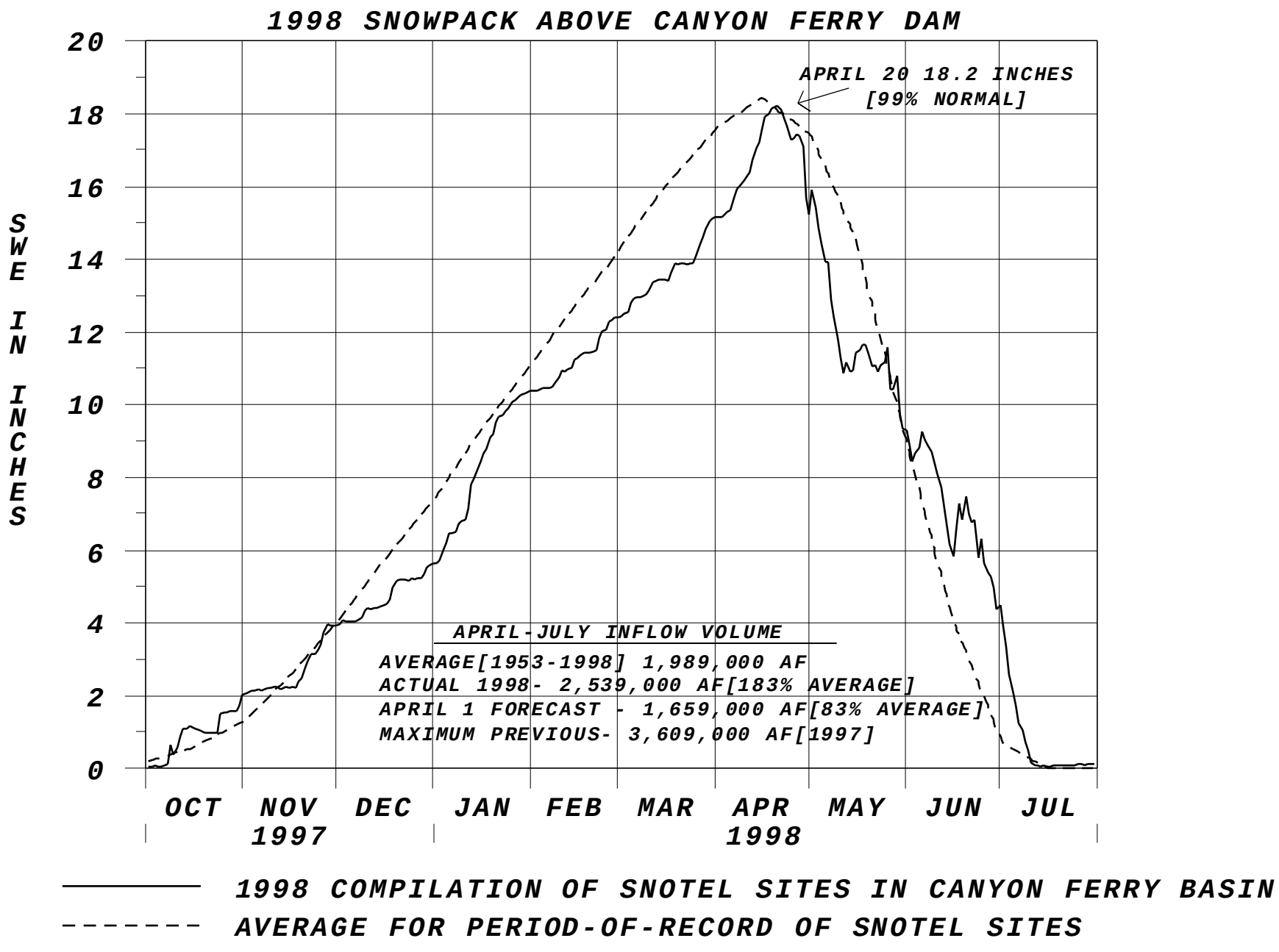


FIGURE 15

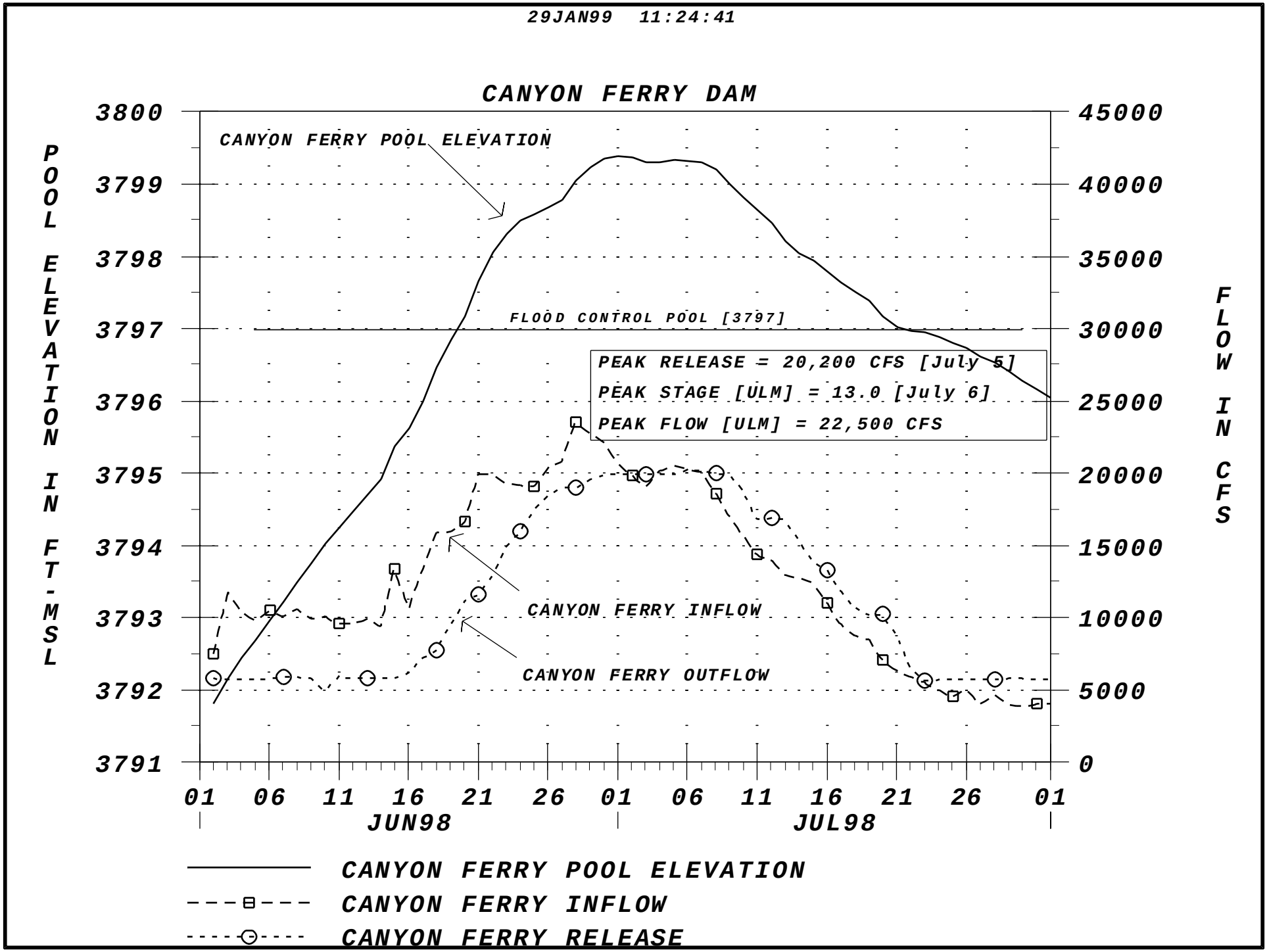

29JAN99 11:24:41
CANYON FERRY DAM
POOL ELEVATION IN FT-MSL
FLOW IN CFS
3800
3799
3798
3797
3796
3795
3794
3793
3792
3791
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
CANYON FERRY POOL ELEVATION
FLOOD CONTROL POOL [3797]
PEAK RELEASE = 20,200 CFS [July 5]
PEAK STAGE [ULM] = 13.0 [July 6]
PEAK FLOW [ULM] = 22,500 CFS
CANYON FERRY INFLOW
CANYON FERRY OUTFLOW
01 06 11 16 21 26 01 06 11 16 21 26 01
JUN98
JUL98
CANYON FERRY POOL ELEVATION
CANYON FERRY INFLOW
CANYON FERRY RELEASE

FIGURE 16

(b) Clark Canyon Dam, Montana. Clark Canyon Reservoir is regulated for flood control primarily to reduce flooding within the City of Dillon and through the Beaverhead Valley downstream of the project. This is accomplished by maintaining "non-damaging flows" (currently estimated at less than 1500 cfs at Barretts) on the river below Clark Canyon Dam to the maximum extent possible. In addition, regulation will be based on providing the maximum service to other purposes for which the project was intended insofar as this regulation is consistent with the primary flood control function" (Standing Instructions to Dam Tender).

Despite the normal snow pack, Clark Canyon pool level reached the fifth highest level since it was closed in 1965. This was a result of prolonged low intensity rain showers and snowmelt of the remaining high elevation snow pack. Increasing the release out of Clark Canyon was limited by bank-full flows on the Beaverhead River below the project. Blacktail Creek flowing into the Beaverhead River at Dillon was flowing near flood stage. Also keeping stages high on the Beaverhead River were the reductions in irrigation demands so all the canals had cut back their diversions and left more water in the river. With the onset of hot and dry weather irrigation demands increased and flow on Blacktail Creek diminished leaving additional capacity in the Beaverhead River. Discharge from Clark Canyon was increased up to a maximum of 1260 cfs as channel capacity became available. Figure 17 presents the 1998 flood control operation of Clark Canyon Dam.

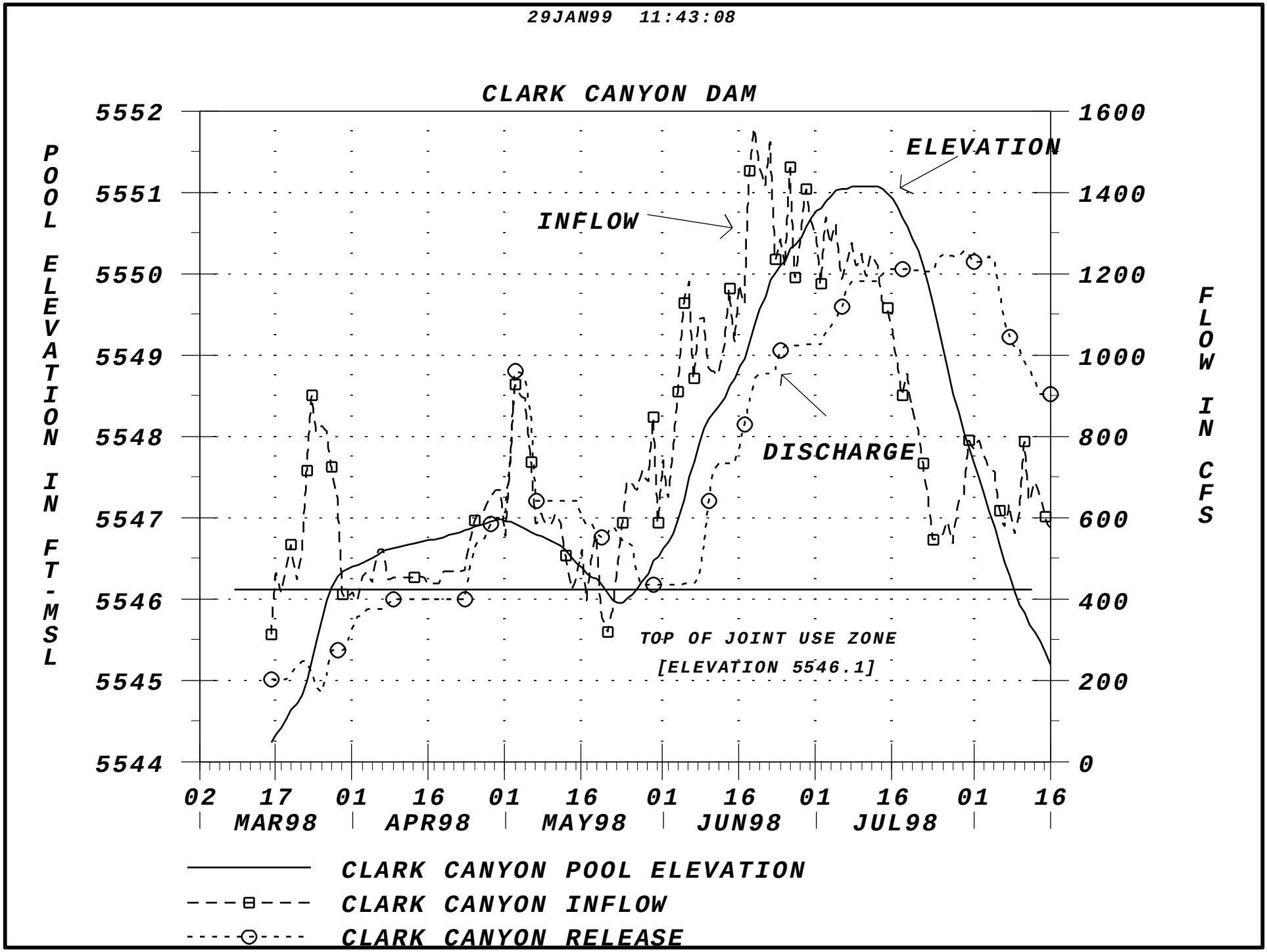

29JAN99 11:43:08
CLARK CANYON DAM
POOL ELEVATION IN FT-MSL
FLOW IN CFS
5552
5551
5550
5549
5548
5547
5546
5545
5544
1600
1400
1200
1000
800
600
400
200
0
ELEVATION
INFLOW
DISCHARGE
TOP OF JOINT USE ZONE
[ELEVATION 5546.1]
02 17 01 16 01 16 01 16 01 16 01 16
MAR98 APR98 MAY98 JUN98 JUL98
CLARK CANYON POOL ELEVATION
CLARK CANYON INFLOW
CLARK CANYON RELEASE

FIGURE 17

(c) Jamestown Dam, North Dakota. As this project is operated in parallel with Pipestem Dam, refer to Section VI, Tributary Runoff and Floods, Pipestem, North Dakota, for a discussion of the operation of Jamestown Dam.

(d) Pactola Dam, South Dakota. Pactola initially entered the flood pool in response to a one-inch rainfall over the Pactola basin that occurred on June 8th. This was followed by almost four inches of rainfall over June 17th and 18th. The latter event resulted in the second highest mean daily inflow of record, 1000 cfs, on June 19th. This was exceeded only by the inflow recorded on May 16th, 1965, of 1130 cfs. Fortunately, the center of the June 17th event was above Pactola Dam, resulting in only minor rises in Rapid Creek through Rapid City. Figure 18 presents a summary of conditions resulting from the four-inch rainfall.

The releases were made using the plan of regulation contained in the November 1976, Report on Reservoir Regulations for Flood Control. The plan is as follows:

Reservoir Elevation In ft-msl		Required Release In C.F.S.
From	To	
4580.20	4582.00	Inflows up to 250
4582.01	4583.00	300
4583.01	4585.00	400
4585.01	4590.00	500

Additional considerations when setting the releases were as follows;

- The flow at Canyon Lake was targeted at 500 cfs. Flows above this level adversely affect recreational facilities located along Rapid Creek through Rapid City.
- Releases over 440 cfs would overtop a rock dike located on the right bank of the flood pool possibly eroding the bank and harming fisheries at that location.
- The Pactola Marina and Forest Service boat ramps are affected by pool levels over a few feet above elevation 4580.2 ft-msl.

By setting the releases at 440 cfs, rather than the 400 cfs called for in the plan, it was hoped that this would prevent the pool from rising above elevation 4585 ft-msl and possibly requiring a 500 cfs release.

Releases were reduced from 430 cfs to 310 cfs prior to July 4th because of a

request by the City of Rapid City. City officials were afraid that water levels in Rapid Creek were just high enough to submerge the low-flow bank line in the channel and put water up over grassy areas. With Rapid City's "Heritage Days" celebration over the 4th of July weekend, it was felt that children would be playing around the water's edge and could easily fall into deeper water.

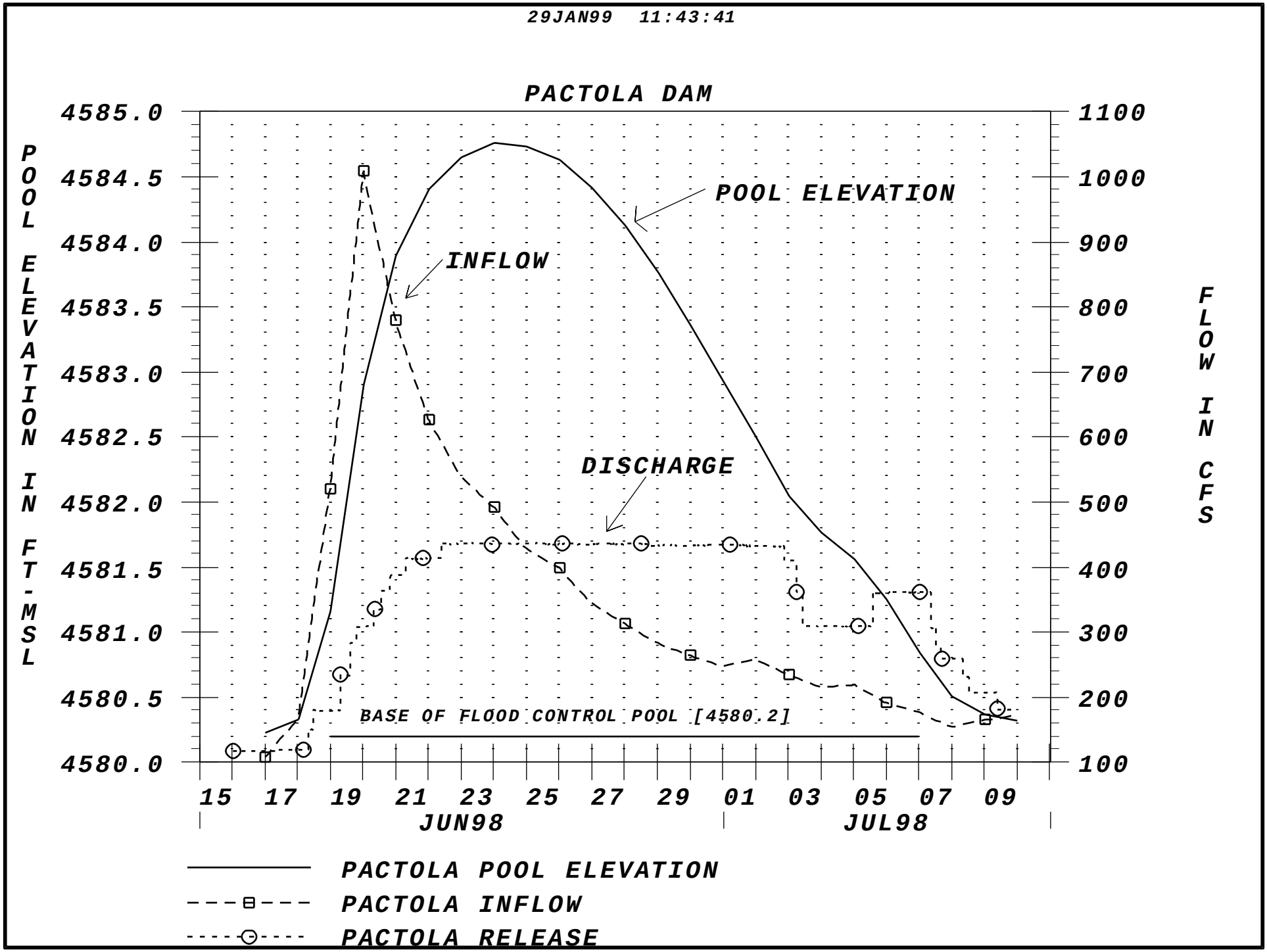

29JAN99 11:43:41
PACTOLA DAM
POOL ELEVATION IN FT-MSL
FLOW IN CFS
4585.0
4584.5
4584.0
4583.5
4583.0
4582.5
4582.0
4581.5
4581.0
4580.5
4580.0
1100
1000
900
800
700
600
500
400
300
200
100
POOL ELEVATION
INFLOW
DISCHARGE
BASE OF FLOOD CONTROL POOL [4580.2]
15 17 19 21 23 25 27 29 01 03 05 07 09
JUN98
JUL98
PACTOLA POOL ELEVATION
PACTOLA INFLOW
PACTOLA RELEASE

FIGURE 18

(e) Yellowtail Dam, Montana. Bighorn Lake is regulated for flood control primarily for the reduction and prevention of flooding downstream from the project, on both the Bighorn and Yellowstone Rivers.

Bighorn Reservoir was in the flood control pool (FCP) at the beginning of the reporting period. Releases were maintained at full power plant capacity (approximately 7,200 cfs) until the pool exited the flood control pool September 2nd, 1997.

Three federal agencies, the Corps of Engineers, Bureau of Reclamation and the Natural Resources Conservation Service (NRCS) are responsible for providing monthly independent April-July inflow forecasts for Bighorn Reservoir. The Corps forecast calculation is based on November and December inflows (antecedent conditions), observed January to June snow pack and actual and anticipated April to June precipitation. Table 14 displays the agencies' 1998 forecasts compared to the actual computed value of 114% of normal.

Table 14
Forecasted % of Normal April - July 1997 Bighorn Lake Reservoir

Agency	Feb 1	Mar 1	Apr 1	May 1	Jun 1
U.S. Army Corps of Engineers	81	89	85	86	71
Bureau of Reclamation	105	102	110	97	63

The inflow forecasts indicated that little or no flood control activities were expected at Bighorn Reservoir. The Bureau's regulation plan was to completely fill the conservation pool with spring snowmelt runoff. The runoff peaked in early July at higher than expected levels causing the pool level to enter the FCP July 10th. The releases were maintained at full power plant capacity (approximately 7,100 cfs).

The release was decreased to 4,500 cfs in the next two weeks as inflows and the pool level decreased. However, late July rainstorms increased inflows and the pool level. The releases were then increased to 6,000 cfs and maintained until the pool exited the FCP in early August.

b. Proposed Operations.

(1) Corps of Engineers. With the exception of Bear Creek, Cherry Creek, Chatfield and Pipestem, all Corps of Engineers tributary dams have ungated service outlets and no gate operations are normally required except for occasional

opening of the low-level outlets for various purposes. Releases to meet downstream water rights can be expected at Bowman-Haley, Cold Brook, Chatfield, Cherry Creek, Bear Creek and Salt Creek #18. Evacuation of stored flood water in these projects is scheduled as soon as practicable after each flood event. Continued low level release operation to maintain pool levels below the top of conservation pool to enhance fisheries habitat at Papillion Creek #18 and Salt Creek #12 is anticipated. Salt Creek #18 has been lowered 5 feet to facilitate shoreline protection projects. The project, Salt Creek #18, should be completed by the spring of 1999. Renovation and construction of shoreline protection and sediment traps is scheduled to the winter or early spring of 1999 for Salt Creeks #2 and 8. Lake levels at these two projects will be held as low as possible until completion of the work.

(a) North Dakota. Flood releases from Pipestem Dam will be coordinated with those from the Bureau's Jamestown Dam. The low-level gate at Pipestem will be opened when water is flowing over the drop inlet to assist in the improvement of lake water quality. At Bowman-Haley Reservoir, the water quality improvement program calls for releases from the low-level drawdown tube during periods of pronounced lake stratification that typically occur in late winter and again in late summer around July 15th. If the local sponsor concurs and winter downstream conditions permit, water will be evacuated from the lower elevations each year starting in early February.

(b) South Dakota. Cold Brook Reservoir inflows up to 1.1 cfs will be released to the Larive Lake Resort when requested to meet their water right.

(c) Colorado. At Chatfield Reservoir, the pool level is expected to fluctuate between elevations 5423.0 and 5432.0 feet msl at all times except during prolonged periods of drought or excessive runoff. Each year, from May 1st to August 31st, the pool level is not expected to fall below elevation 5426.85 ft-msl (20,000 acre-feet) for recreational purposes. Storage of water above elevation 5426.85 ft-msl to elevation 5432.0 ft-msl will depend on the availability of free water and/or the desire of the City of Denver to store water. During the Colorado irrigation season, inflows to Cherry Creek Reservoir will be calculated by the Hydrology and Water Control Section and the State Engineer on a daily basis and releases will be balanced on a weekly basis to comply with State water rights. The Colorado Department of Parks and Recreation has been working to obtain water from several sources, including the Denver Metro Sewer return flows, to exchange with calls made against Cherry Creek. Releases will be made at Cherry Creek Reservoir in May or June to flush sediment from around the gates in the intake structure. Flushes will not be scheduled during the December through March period or if there is downstream flooding. The flushing schedule utilizes approximately 150 to 250 acre-feet of water. At Bear Creek Reservoir, the low-

level gate will be opened when practical during the June through August period when the lake typically stratifies to assist in the improvement of lake water quality, if requested. If the lake falls below elevation 5558.0 feet msl, releases from the low level gates may need to be done in order to satisfy downstream water rights requests. All other operations of the Colorado reservoirs will be done in accordance with the individual water control plan.

(d) Nebraska. At Salt Creek Dam #18, releases of inflow up to a total of 11.57 cfs may be made for water rights calls from downstream landowners. Releases up to 3 cfs without proving inflow will be made when required to satisfy downstream water rights. Low-level releases will be made when practicable from the Papillion Creek projects to allow water to be discharged from lower elevations in an attempt to improve lake water quality. Drawdowns of up to 2.5 feet below the top of conservation pool at Salt Creek Dam #12 (1230.4 ft-msl) and Papillion Dam #18 (1108.0 ft-msl) were initiated at the end of the summer and will continue until the Spring of 1999. Crappie habitat in the form of native grasses was planted and spring inflows will be allowed to refill the projects up to the top of conservation pool level. All other operations of the Nebraska reservoirs will be done in accordance with the individual water control plan.

(2) Bureau of Reclamation. As in the past, the Bureau will continue to operate their reservoirs to meet flood control commitments and to coordinate operations with other interests to achieve optimum use of water resources. Generally, all reservoirs will be operated as close to the top of their conservation pools as possible. Pertinent special operating plans are described as follows: Boysen, Canyon Ferry, Clark Canyon, Tiber and Yellowtail Reservoirs require evacuation and refill of joint-use storage for flood control based on mountain runoff inflow forecasts.

(a) Canyon Ferry. The Canyon Ferry Reservoir Operating Plan requires that releases are adjusted as soon as the storage has peaked, usually in June or July, so the pool will be drawn to near elevation 3780.0 ft-msl by the following March 1st. In addition, the Montana Power Company will try to limit releases from Hebgen Reservoir to maintain Canyon Ferry pool below elevation 3794.0 ft-msl after December 1st. Storage below elevation 3794.0 ft-msl prior to winter freeze up is desired to prevent ice jam problems at the upper end of the lake. Beginning near the first of January, releases will be set based on the most probable spring inflow forecast to allow the reservoir to fill to elevation 3797.0 ft-msl near the end of June.

(b) Tiber (Lake Elwell). In accordance with the Water Control Agreement, the joint-use zone at Tiber Reservoir will be vacated to elevation

2976.0 ft-msl by March 1st. March-June releases are based on forecasted inflows with the objective of filling Lake Elwell to elevation 2993.0 ft-msl by the end of June. However, if necessary, March-June releases may be based on filling the reservoir to as high as elevation 3008.0 ft-msl by the end of June to provide replacement storage and assist the Corps in the operation of the mainstem reservoir system.

(c) Yellowtail. Yellowtail Reservoir will be regulated to be no higher than elevation 3630.0 ft-msl by November 30th to reduce chances of headwater ice problems. The drawdown will continue through the winter months so that the pool elevation will be no higher than 3605.0 ft-msl before the beginning of spring runoff based on a normal runoff forecast. March through July releases will be based on forecasted inflows with the objective of filling Yellowtail Reservoir to elevation 3640.0 ft-msl by the end of July.

(d) Others. Replacement storage up to a combined total of 1,075,500 acre-feet can be made available in Clark Canyon, Tiber and Canyon Ferry Reservoirs on a forecast basis. Fresno Reservoir in Montana is lowered each year and regulated to provide flood control in accordance with a July 4, 1957 Letter of Understanding. In addition to the reservoirs covered in this report, other Bureau reservoirs, without allocated flood control storage space, will provide flood control in their normal operation of storing seasonal runoff. Some of these projects are Gibson Dam in Montana and Bull Lake, Pathfinder, Seminoe, and Buffalo Bill Dams in Wyoming.

VII. MAJOR REGULATION PROBLEMS.

a. Water Quality. Water quality problems, including algal blooms and low dissolved oxygen, exist at certain tributary reservoirs. The principal water quality issues and problems at each of the projects during 1997-1998 are covered in a separate report prepared by the Water Quality Unit.

b. Downstream Channel Capacity. Inadequate or reduced channel capacity is a problem below many of the tributary reservoirs. Encroachment by natural plant growth due to low flows, by flood deposits left in place, and by human construction and agriculture practices, are common. In some cases, downstream channel capacity is significantly less than flood control releases. For example, the channel downstream of Cold Brook Dam is not defined due to residential construction. The channel capacity of the South Platte River below the Tri-Lakes projects hinders or prevents releases in accordance with the three-reservoir (Chatfield, Bear Creek, and Cherry Creek) plan of regulation to evacuate flood storage. Compounding this situation is the fact that the reservoir design routings for Chatfield, Bear Creek and Cherry Creek Reservoirs were made independently of

each other and that the individual routings neglected (1) the effect of the releases from the other two dams in the three-reservoir system, (2) the effect of the incremental runoff below the dams, and (3) the actual channel capacity below the three dams.

c. Releases for Purposes other than Authorized Project Functions. No releases were made for purposes other than authorized project functions.

d. Potential Hazardous Conditions. A potential problem exists if water is released over the project spillways where the land downstream of the project has been developed into urban areas. A hazard-to-life condition exists if a significant flow of water is discharged over the spillways at these projects.

e. Dam Safety Issues. There also is a hazard-to-life condition if a flood event occurs that causes overtopping of the dam embankment. Dams located above populated areas are normally designed to safely pass a Probable Maximum Flood (PMF) without overtopping the embankment. The PMF is estimated using probable maximum precipitation estimates developed by the National Weather Service. Recent studies indicate that nine Corps of Engineers and eleven Bureau of Reclamation tributary reservoirs cannot safely pass the PMF without being overtopped. Following is information on each of these projects along with the status of potential corrective actions:

(1) Corps of Engineers Dams.

(a) Cherry Creek Dam. Corps of Engineers dams located above populated areas are designed to store and/or pass a PMF without overtopping the embankment. The most recent precipitation estimates for this area indicate that the reservoir could safely pass no more than 75% of the PMF under existing development with adequate freeboard.

The probability of overtopping of the Cherry Creek embankment is very remote. However, the consequences of failure would be catastrophic. The population within the potential Cherry Creek flood area downstream from the dam is estimated to be as high as 138,000. Potential flood damages are nearly $3 billion for the with dam failure condition. A dam safety evaluation study is underway to determine optimal solutions to the hydrologic inadequacy of Cherry Creek Reservoir.

(b) Cold Brook Dam. On August 11, 1993, the revised draft reconnaissance report for the Cold Brook Dam hydrologic improvement assessment was completed. The report concluded that the Cold Brook project was hydrologically deficient as it could safely pass only 48 percent of the PMF with adequate freeboard. A dam safety evaluation study will be initiated in FY2000 to determine optimal solutions to the hydrologic inadequacy of Cold Brook Dam.

(c) Salt Creek Dams. Recent studies indicate that Salt Creek Dams 4,8,9,13,14,17, and 18 will be overtopped by the PMF and all of the projects would have less freeboard than originally designed. This is a result of spillway crests that are higher than the original design and dam crests that are lower than the original design. In addition, new criteria for the antecedent flood prior to the PMF results in a higher maximum pool during the PMF routing. Funds have been requested to restore the spillway crests and dam crests to the original design elevations. Funds have also been requested to conduct a dam safety evaluation study concerning the higher maximum pool during the PMF routing.

(2) Bureau of Reclamation Dams.

(a) Clark Canyon Dam. The PMF for Clark Canyon Dam is characterized by a peak inflow of 166,800 cfs and a volume of 506,000 acre-feet. Clark Canyon Dam will be overtopped by floods exceeding 58 percent of the PMF. The Bureau of Reclamation's recommended corrective action is the implementation of an Early Warning System (EWS). Work has been initiated on the EWS.

(b) Canyon Ferry Dam. The PMF for Canyon Ferry Dam is characterized by a peak inflow of 506,000 cfs and a 15-day volume of 2,035,000 acre-feet. Canyon Ferry Dam will be overtopped by floods exceeding 94 percent of the PMF. The potential for dam failure during overtopping is considered to be low. Corrective actions are not anticipated.

(c) Tiber Dam. The PMF for the Tiber Dam is characterized by a peak inflow of 695,926 cfs and a 15-day volume of 1,443,000 acre-feet. Tiber Dam will be overtopped by floods exceeding 59 percent of the PMF. An EWS is anticipated as the recommended corrective action.

(d) Boysen Dam. The PMF for Boysen Dam is characterized by a peak inflow of 845,000 cfs and a 15-day volume of 2,820,000 acre-feet. Boysen Dam will be overtopped by floods exceeding 48 percent of the PMF. The Bureau of Reclamation's recommended corrective action is the implementation of an early warning system (EWS) in conjunction with the EWS's at upstream dams (Pilot Butte and Bull Lake Dams). Work has been initiated on the EWS.

(e) Yellowtail Dam. The PMF for Yellowtail Dam is characterized by a peak inflow of 887,000 cfs and a volume of 4,700,000 acre-feet. Yellowtail Dam will be overtopped by floods exceeding 31 percent of the PMF. The potential for dam failure during overtopping is considered to be low. Corrective actions are not anticipated.

(f) Heart Butte Dam. The PMF for Heart Butte Dam is characterized by a peak inflow of 161,400 cfs and a volume of 558,600 acre-feet. Heart Butte Dam was modified in 1987 to safely pass the PMF.

(g) Jamestown Dam. The PMF for Jamestown Dam is characterized by a peak inflow of 110,200 cfs and a volume of 589,500 acre-feet. Jamestown Dam will be overtopped by floods exceeding 91 percent of the PMF. Piping failure of Jamestown Dam during high reservoir conditions was a dam safety concern. A toe drain system was installed in 1996 and a downstream blanket was placed during 1997 and 1998.

(h) Keyhole Dam. The PMF for Keyhole Dam is characterized by a peak inflow of 513,600 cfs and a volume of 785,800 acre-feet. Keyhole Dam will be overtopped by floods exceeding 75 percent of the PMF. The Bureau of Reclamation's recommended corrective action is the implementation of an EWS.

(i) Pactola Dam. The PMF for Pactola Dam is characterized by a peak inflow of 321,240 cfs and a volume of 159,800 acre-feet. The PMF for Pactola Dam has not been updated since 1981. Pactola Dam was modified in 1985-1987 to safely pass the current PMF.

(j) Shadehill Dam. The PMF for Shadehill Dam is characterized by a peak inflow of 423,200 cfs and a volume of 1,324,900 acre-feet. Shadehill Dam will be overtopped by floods exceeding 77 percent of the PMF. The likely corrective action will be the implementation of an EWS.

(k) Glendo Dam. The PMF for Glendo Dam is characterized by a peak inflow of 627,100 cfs and a volume of 2,197,000 acre-feet. Glendo Dam will be overtopped by floods exceeding 40 percent of the PMF. The Bureau of Reclamation has completed an extensive analysis of potential corrective actions for all of its mainstem North Platte River Dams. These studies have resulted in the recommendation to modify Glendo Dam to pass 80 percent of the PMF (modification of Pathfinder Dam, and Seminoe Dam is also recommended). The recommendation for modifications is based upon an analysis of the consequences of dam failure. The Bureau of Reclamation's studies indicate that failure of any of the larger mainstem dams (Seminoe Dam, Pathfinder Dam or Glendo Dam) will

cause the subsequent failure of all downstream dams, including Kingsley Dam in central Nebraska.

VIII. WATER CONTROL MANUALS. Work progressed on several Water Control Manual updates during the year. The draft Water Control Manual updates for the Chatfield, Cherry Creek, and Bear Creek projects are complete and under review. During the public involvement process, most of the public comment involved issues of reallocation of a portion of the flood control storage to multipurpose storage, including water supply storage. Since this type of reallocation of storage was beyond the scope of a water control manual update, scoping for a General Investigation (GI) funded reallocation study was initiated in conjunction with the state of Colorado. The draft water control manual updates do not contain an evaluation of alternative water control plans. These evaluations will be completed as part of the Reallocation Study that will be initiated in FY99.

Funding was received in FY96 for initiation of water control manual updates for Pipestem and Jamestown Reservoirs. Phase I work in FY96 included developing and updating hydrologic models. Phase II work in FY97 included updating stage-damage relationships and initiating environmental assessments, and evaluation of operational alternatives. Phase III work in FY98 and FY99 will include selection of the preferred alternative and a public involvement process.

Water control manuals will be updated on an approximate 10-year cycle, or more frequently, if required. If funds are not available for a comprehensive review and update of a water control manual, at a minimum "baseline" O&M funds will be used to update area-capacity curves, rating curves, stage-damage curves, historical records, and documentation of large runoff events. Table 15 indicates work priorities while Table 16 lists the current status of all water control manuals.

TABLE 15

WORK PRIORITIES Update Water Control Manuals		
Priority	**Project**	**Remarks**
1	Papillion	Scheduled completion FY-99
2	Westerly Creek/Kelly Road	Scheduled completion FY-99
3	Lake Audubon	Scheduled completion FY-99
4	Canyon Ferry	Scheduled completion FY-99
5	Glendo	Completed FY-98
6	Chatfield	Scheduled completion FY-99
7	Bear Creek	Scheduled completion FY-99
8	Cherry Creek	Scheduled completion FY-99
9	Pipestem/Jamestown	Scheduled completion FY-99
10	Pactola	Scheduled start FY-99
11	Cold Brook	Scheduled start FY-99
12	Cottonwood Springs	Scheduled start FY-99

TABLE 16
SCHEDULE FOR REVISION OF WATER CONTROL MANUALS
FY 1999 - FY 2004

Dam/Reservoir Name	Stream	Owner	District	Date of Manual or Last Revision	Scheduled Completion Date of Next Revision	Type of Revision - Manual (M) or Plan (P)	Estimated Total Cost $1000
Kelly Rd/Westerly Creek	Westerly Creek	CE	NWO	Dec 92	FY 1999	M	30
Papillion Creek Dams (4)	Papillion Creek/Tribs	CE	NWO	Dec 92	FY 1999	M	30
Chatfield	South Platte River	CE	NWO	Apr 73	FY 1999	M/P	110
Cherry Creek	Cherry Creek	CE	NWO	Oct 71	FY 1999	M/P	120
Bear Creek	Bear Creek	CE	NWO	Mar 77	FY 1999	M/P	90
Pipestem	Pipestem Creek	CE	NWO	Aug 86	FY 1999	M/P	60
Cold Brook	Cold Brook	CE	NWO	Aug 54	FY 2000	M	30
Cottonwood Springs	Cottonwood Springs	CE	NWO	Sep 73	FY 2000	M	20
Cedar Canyon	Deadman's Gulch	CE	NWO	Jan 71	FY 2001	M	20
Salt Creek Dams (10)	Salt Creek/Tribs	CE	NWO	Dec 78	FY 2001	M	40
Bowman-Haley	N. Fork Grand River	CE	NWO	Mar 87	FY 2001	M	30
Lake Pocasse	Spring Creek	CE	NWO	Jun 89	FY 2001	M	20
Lake Audubon	Snake Creek	CE	NWO	Dec 92	FY 2002	M	30
Bull Hook/Scott Coulee	Bull Hook Creek	CE	NWO	Mar 91	FY 2002	M	20
Canyon Ferry	Missouri River	BR	NWO	Apr 95	FY 1999	M	40
Jamestown	James River	BR	NWO	Nov 57	FY 1999	M/P	60
Pactola	Rapid Creek	BR	NWO	Feb 77	FY 2000	M	50
Boysen	Wind River	BR	NWO	Dec 66	FY 2000	M	50
Yellowtail	Bighorn River	BR	NWO	Jan 74	FY 2000	M	40
Clark Canyon	Beaverhead River	BR	NWO	Jun 76	FY 2001	M	40
Tiber	Marias River	BR	NWO	Dec 59	FY 2002	M/P	60
Heart Butte	Heart River	BR	NWO	Feb 51	FY 2003	M	30
Shadehill	Grand River	BR	NWO	Nov 51	FY 2003	M	30
Keyhole	Belle Fourche River	BR	NWO	Jun 69	FY 2004	M	30
Glendo	North Platte River	BR	NWO	Apr 70	FY 2005	M	40

IX. DATA COLLECTION PROGRAM AND PROCEDURES.

a. Collection of Water Control Data. Data from hydrologic gages for water control management are obtained from various sources including contract observers, project offices, National Weather Service, Geological Survey, Bureau of Reclamation, state offices and Data Collection Platforms (DCPs) operated by the District. The National Weather Service (NWS) provides current weather conditions, one to five day weather forecasts, precipitation reports, river level data and special hydrologic forecasts including flood warnings. Since March 1986, this service, called "Hydromet", has been retrieved from a NWS computer in Kansas City.

The Section also obtains weather information from several commercial vendors. They include Alden, DTN (Data Transmission Network, Inc.) and various Internet home pages. Regional weather radar composites, as well as a wide range of weather data and forecasts, are provided by satellite receiver to a DTN workstation. Regional and National radar data can be looped to track heavy rainfall in the District on this device.

The final source of weather information is from the Internet and the World Wide Web (WWW). There are many sites scattered throughout the United States and the World which provide a variety of weather products at no cost. More detailed products require a subscription or payment. Internet sites include universities, the NWS and the commercial vendors of weather products. Products available range from raw data like precipitation and temperature to upper air maps and forecast products containing "value added" graphics.

Since early 1992, the Omaha District, Water Control Section has been utilizing an HECDSS database for storing river, reservoir and weather data. A commercial software package reads data retrieved from the Section's Domsat Read Only Terminal (DROT) system. Precipitation and stage data are also read into HECDSS from the Papillion Creek flood warning system. The combined data set is then screened using HEC's DATCHK and DATVUE programs.

The DROT was installed in the Fall of 1992. A 7.5-foot diameter satellite dish was installed on the roof of the Zorinsky Federal Building. The dish receives all DCP transmissions in the continental United States. A cable runs directly from the satellite dish to two data capture workstations in the Hydrologic Engineering Branch.

b. Automated Remote Sensors. State-of-the-art, remote site, satellite data transmissions are utilized for water control management. Satellite collection

equipment being used by the District was purchased from Sutron Corporation. The equipment was and is installed and maintained by Section personnel and/or by contract. Currently, there are 21 DCPs in Montana, 5 in Wyoming, 21 in Colorado, 13 in North Dakota, 27 in South Dakota, 46 in Nebraska and 21 in Iowa for a total of 154 sites.

The DCPs in the District transmit real-time river and reservoir levels, precipitation, evaporation, wind, and water and air temperature data. The hourly data collected by these remote sensors in transmitted to two ground receiving sites located in Omaha, Nebraska (Corps of Engineers) and Boise, Idaho (Bureau of Reclamation). This information is currently transmitted via GOES-west and GOES-central satellites located at 135 degrees west longitude and 112 degrees west longitude, respectively.

c. Cooperative Hydrologic Programs. Funding for the Omaha District's stream gaging activities is furnished through two programs. The Cooperative Stream Gaging (FC-33) program provides support to seven Geological Survey Districts. The districts are Colorado, Iowa, Montana, Nebraska, North Dakota, South Dakota and Wyoming. Collection and publication of data such as stage, discharge, sediment, water quality and ground water records are the primary functions of this program. The cooperative program also provides funding for DCP and telemark maintenance. The National Weather Service Reporting Network (FC-50) program provides financial support for the collection of data from 40 gaging stations within six river district offices. Formerly operated by the Corps of Engineers, these stations are required for reservoir regulation. The stations are in addition to the regular National Weather Service reporting stations.

d. Water Quality. The Omaha District Water Quality Unit conducts sampling analysis of physical, chemical, and biological parameters on reservoirs in the Omaha District. Projects are normally sampled six times per year by in-house personnel or under contract. Occasional surveys and special investigations on all projects are conducted as necessary to identify or resolve specific water quality problems.

In-house personnel sample the Papillion Creek and Salt Creek Reservoirs. Bowman-Haley, Cold Brook, Chatfield, Bear Creek, Cherry Creek, Lake Audubon, Lake Pocasse, Lake Yankton, Pipestem and the Missouri River mainstem reservoirs are sampled by area personnel or under contract. Sampling at Cottonwood Springs Reservoir should begin in FY99 since the project now impounds sufficient water.

Inflows and releases are sampled by area or in-house personnel at all tributary projects. Inflows and releases of mainstem projects are sampled by area

personnel or under contract by the USGS.

Continual remote monitoring and data storage of dissolved oxygen, temperature, conductivity, and pH are conducted downstream of Fort Peck, Garrison, Oahe, Big Bend, Fort Randall, and Gavins Point Projects. The monitoring is conducted by area personnel.

e. Sediment.

(1) Bed and Suspended Sediment Sampling. The Omaha District under the Cooperative Stream Gaging Agreement with the Geological Survey operates eight suspended sediment sampling stations. Four of these stations are located on the Missouri River at Landusky, Montana; Sioux City, Iowa; Omaha, Nebraska; and Nebraska City, Nebraska. In July 1998, an in-house survey crew collected bed material samples of the Missouri River from Ponca, Nebraska (river mile 773) downstream to Saint Louis, Missouri (river mile 0).

(2) Sedimentation Surveys. Complete sedimentation surveys of the Omaha District's tributary reservoir projects are completed at approximately 10-year intervals, if funding is available. The mainstem project Lake Sharpe near Pierre, South Dakota and the tributary project, Cherry Creek in Denver, Colorado were surveyed during this reporting period.

X. WATER CONTROL INITIATIVES.

a. Missouri River Region Water Control Data System Master Plan. The Omaha District currently uses HEC-DSS as the primary water control database. The Omaha District has been selected as one of four sites for the deployment of the Water Control Data System Version 1.0 software. The deployment is scheduled to be complete in May of 1999.

b. Water control is becoming more involved with Geographical Information Systems (GIS) and would like to develop geographic, hydrologic, hydraulic, and economic tools to help in decision making and briefing of other District elements and the District Commander.

XI. FERC Applications. Two Federal Energy Regulatory Commission (FERC) permits were reviewed during the report period. The draft EIS for the Missouri-Madison Hydroelectric Project (FERC Project No. 2188) and the City of Boulder's proposed Silver Lake Hydroelectric Project (FERC Project No. 11531).

XII. TRAINING AND METHODS. During the period November 1997 to November 1998, employees in the Section attended the courses listed in Table 17.

Table 17
Training Courses Attended

Course Title	Course Location	Dates
GIS Introduction to Arc View	Omaha, NE	Jan 98 (16 hrs)
Water Safety Training	Omaha, NE	April 98 (4 hrs)
HTRW Refresher	Omaha, NE	May 98 (8 hrs)
Position Classification	Omaha, NE	Sept 98 (16 hrs)
Conflict Management	Lincoln, NE	Nov 98 (8 hrs)

XIII. PERSONNEL. In 1997 the Hydrology, Water Quality, and Water Control Section of the Hydrology Branch were combined into the Hydrology and Water Control Section. The reorganized Hydrology and Water Control Section consists of one Supervisory Hydraulic Engineer, one Hydraulic Engineer Technical Specialist, one Water Quality Technical Specialist, seven hydraulic engineers, one hydraulic engineer/meteorologist, three hydrologic engineering technicians, one computer systems administration programmer, one biologist, two part-time civil engineering student-trainees, one part-time biology student-trainee and one secretary; a total of twenty personnel.

PLATES

SUMMARY OF ENGINEERING DATA - FEDERAL RESERVOIRS WITH AUTHORIZED FLOOD CONTROL
MISSOURI RIVER TRIBUTARIES - U.S. ARMY ENGINEER DISTRICT - OMAHA
CORPS OF ENGINEER DAMS - COLORADO

ITEM NO	SUBJECT	BEAR CREEK	CHATFIELD	CHERRY CREEK	KELLY ROAD	WESTERLY CREEK
	GENERAL					
1	Location of dam	3 mi. S W of Denver, CO	2 mi. S of Denver, CO	10 mi. S E of Denver, CO	Lowry A.F.B., Denver, CO	Lowry A.F.B., Denver, CO
2	River and river mile	Bear Creek R M 8	South Platte River R M 321	Cherry Creek R M 11.4	Westerly Creek	Westerly Creek
3	Drainage area (sq. mi.)	236	3,018	386	10.84	9.29
4	Reservoir length (mi.)	0.5 at elevation 5558	2.0 at elevation 5430	1.5 at elevation 5550	Normally dry	Normally dry
5	Location of Damtender	At Chatfield Dam	On site	At Chatfield Dam	Rocky Mt. Area	Rocky Mt. Area
6	Travel time to Missouri River	2 weeks	2 weeks	2 weeks	2 weeks	2 weeks
7	Max. discharge of record	8,600 cfs July 1896	110,000 cfs June 1965	58,000 cfs June 1965	Not available	Not available
8	Project cost (1)	$61,700,00	$101,130,000	$14,670,000	$232,000 (Original Cost)	Not available
	DAM AND EMBANKMENT					
9	Top of dam - ft. MSL	5689.5	5527	5644.5	5372.0 5363.0 WestEmb.	5434.5
10	Length of dam - ft.	5,300-main 2,100-South	13,136	14,300	4,700	9100
11	Height of dam - ft.	179.5-main 65-South	147	141	32	45.5
12	Stream bed - ft. MSL	5,510	5,380	5504	5,340	5389
13	Abutment formation	Clay,shale,siltstone,sandstone	Sandy overburden-Dawson F.	Sandstone, clay, silt	Overburden-sandy clay	Nto available
14	Type of fill	Rolled earth	Rolled earth	Rolled earth	Rolled earth	Rolled earth
15	Fill quantity in cu. yds.	11,346,000-main 770,000-So.	14,650,000	13,000,000	200,000	Not available
16	Date of closure	July 1977	August 1973	October 1948	November 1953 Rehab 1978	July 1991
17	Date of initial fill (base F.C.)	May 1979	June 1979	March 1960	Dry Pool	Dry Pool
	SPILLWAY					
18	Discharge capacity - cfs	153,500 cfs at el. 5684.5	188,000 cfs at el. 5521.6	38,350 cfs at el. 5636.2	3,600 cfs at elevation 5366.8	46,900 cfs at el. 5431.4
19	Crest elevation - ft. MSL	5667.0	5500.0	5608.7 (4)	5362.0	5419.0
20	Width - ft.	800	500	67	120	400
21	Gates, number, size, type	Ungated earth channel	Ungated converging chute	Ungated earth channel	Uncontrolled concrete U wall and chute	Uncontrolled grass lined, earth cut
	RESERVOIR ELEVATION AND AREA	(1987 data)	(1991 data))	(1988 data)		
22	Maximum pool	5684.5 1220a	5521.6 5977a	5645.0 (3) 4820a	5366.8 43a	5431.4 375a
23	Top of flood control pool	5635.5 715a	5500.0 4770a	5608.7 3101a	5362.0 38a	5419.0 275a
24	Top of multipurpose pool	5558.0 107a	5432.0 1423a	5550.0 844a	none	none
25	Top of inactive pool	5528.0 16a	none	none	none	none
	STORAGE ZONES (Elev. - Capacity)	(1987 data)	(1991 data)	(1988 data)		
26	Surcharge	5635.5 - 5684.5 47,352AF	5500 - 5521.6 116,268AF	5608.7-5645.0 142,069AF(4)	5362.0 - 5366.8 200AF	5419.0 - 5431.4 3950AF
27	Flood Control	5558.0 - 5635.5 28,715AF	5432 - 5500.0 206,729AF	5550.0 -5608.7 110,037AF(4)	5342.0 - 5362.0 360AF	5389.0 - 5419.0 4150AF
28	Multipurpose	5528.0 - 5558.0 1,909AF	5385 - 5432 27,018AF	5504.0 -5550.0 12,805AF	none	none
29	Inactive	5510 - 5528.0 65AF	5377 - 5385 28AF	none	none	none
30	Gross (top of flood control pool)	30,689AF	235,098AF	92,126AF(4)	360AF	4150AF
	OUTLET WORKS					
31	Number and size - conduits	1 - 7 ft. circular - upstream 1 - 7 x 10.5 ft. - downstream	2 - 11 x 16 ft. oval conduit	2 - 8 x 12 ft. oval conduit 1 - 12 ft. circular conduit	1 - 5.5 ft. circular conduit 1 - 30 in. CMP	1 - 4 ft. prestressed concrete cylinder pipe
32	Conduit length - ft.	1690 ft. Ungated drop inlet - el. 5558	1280 ft.	679.5 ft.	260 ft.	907 ft.
33	Number - size - type gates	2 - 3 x 6 ft. hydraulic slide 2 - 1 x 1 ft. slide-gate on gate	2 - 6 x 13.5 ft. hydraulic slide 2 - 2 x 2 ft. slide-gate on gate 1 - 72 in. butterfly	5 - 6 x 9 ft. - hydraulic slide 2 - 18 in. bypass gates	Ungated drop inlet-el. 5358.4 Gated inlet - el. 5342.0	1 - 48 x 24 inches hand operated sluice
34	Discharge capacity	2,169 cfs at el. 5667	8400 cfs at el. 5500.0	8100 cfs at el. 5598.0	570 cfs at el. 5362.0	98 cfs at el. 5431.4
35	**POWER INSTALLATION**	none	none	none	none	none

(1) Costs are as of 9-30-80.
(2) Bowman Haley Spillway equipped with Fuse Plug (Crest Elevation 2780.7 ft MSL).
(3) Due to updated Hydrological Improvement Assesment for Cherry Creek Reservoir, with the maximum pool the dam would be overtopped.
(4) Top of Flood Control Pool is elevation 5598.0, which was original spillway crest elevation. Due to sloughing of spillway side slopes, spillway crest elevation is 5608.7 ft. MSL

January 1995

PLATE 2

SUMMARY OF ENGINEERING DATA - FEDERAL RESERVOIRS WITH AUTHORIZED FLOOD CONTROL
MISSOURI RIVER TRIBUTARIES - U.S. ARMY ENGINEER DISTRICT - OMAHA
CORPS OF ENGINEERS DAMS - PAPILLION CREEK BASIN, NEBRASKA

ITEM NO	SUBJECT	DAM NO. 11 (Glenn Cunningham Lake)	DAM NO. 16 (Standing Bear Lake)	DAM NO. 18 (Zorinsky Lake)	DAM NO. 20 (Wehrspann Lake)
	GENERAL				
1	Location of dam	93rd State Street	132nd and Fort Street	156th and "F" Street	156th and Giles Road
2	River and mileage	Knight Creek -	Tributary Big Papio -	Boxelder Creek -	Trib. South Branch Papio-
3	Drainage area in square miles	17.8	6	16.4	13.1
4	Reservoir length in miles	2.5	1.0	1.5	1.5
5	Location of Damtender	Missouri River Project Office	Missouri River Project Office	Missouri River Project Office	Missouri River Project Office
6	Travel time to Missouri River	5 - 10 Hours	5 - 10 Hours	5 - 10 Hours	5 - 10 Hours
7	Max. discharge of record	-	-	-	-
8	Project cost (1)	$11,800,000	$4,500,000	$20,656,000	$14,934,000
	DAM AND EMBANKMENT				
9	Top of dam - ft. MSL	1152	1130.0	1143.5	1131
10	Length of dam - ft.	1940	1460	1400	1810
11	Height of dam - ft.	67	70	64	59
12	Stream bed - ft. MSL	1085	1060	1079.5	1069
13	Abutment formation	Lean clay loess	Lean clay loess	Lean clay loess	Lean clay loess
14	Type of fill	Rolled earth	Rolled earth	Rolled earth	Rolled earth
15	Fill quantity in cu. yds.	656,000	481,000	1,263,000	767,450
16	Date of closure	5 Aug 1974	3 Oct 1972	15 July 1984	21 Sep 1982
17	Date of initial fill	2 Sep 1977	24 Oct 1977	22 April 1992	26 May 1987
	SPILLWAY				
18	Discharge capacity - cfs (max. pool)	18,700	9,500	30,000	12,000
19	Crest elevation - ft. MSL	1142	1121	1128.2	1120
20	Width - ft.	700	250	400	600
21	Gates, number, size, type	Ungated earth channel	Ungated earth channel	Ungated earth channel	Ungated earth channel
	RESERVOIR ELEVATION AND AREA	(1987 data)	(1989 data)	(1985 data)	(1984 data)
22	Maximum pool	1147 1170A	1127 390A	1138.2 861A	1125.8 806A
23	Top of flood control pool	1142 991A	1121 313A	1128.2 599A	1113.1 489A
24	Top of multipurpose pool	1121 377A	1104 125A	1110.0 259A	1095.83 (2) 239A
25	Top of inactive pool				
	STORAGE ZONES (Elev. - Capacity)	(1987 data)	(1989 data)	(1985 data)	(1984 data)
26	Surcharge	1142 - 1147 5,405AF	1121 - 1127 2,110AF	1128.2 - 1138.2 7,290AF	1113.1 - 1125.8 8,128AF
27	Flood control	1121 - 1142 13,899AF	1104 - 1121 3,591AF	1110.0 - 1128.2 7,649AF	1095.83 - 1113.1 6,119AF
28	Multipurpose	1085 - 1121 3,262AF	1060 - 1104 1,285AF	1060.5 - 1110.0 3,037AF	1069 - 1095.83 2,682AF
29	Inactive				
30	Gross Storage (Excl of surcharge)	17,161AF	4,876AF	10,686AF	8,801AF
	OUTLET WORKS				
31	Number and size - conduits	1 - RCP - 54" Dia.	1 - RCP - 36" Dia.	1 - RCP - 48" Dia.	1 - RCP - 48" Dia.
32	Conduit length - ft.	680	736	782	656
33	Disch capacity of conduit - cfs(at top of FC Pool)	570	160	460	490
34	Gated outlets (No - size - invert. elev. of intake)	1 - 30" x 30" 1,100	1 - 24" x 36" 1,080.0	1 - 30" x 30" 1,090.0 1 - 6" diameter 1,104.25	1 - 30" x 30" Dia. 1,077.0 1 - 6" diameter 1,090.0
35	Disch capacity of gated outlets - cfs	90	90	140	140
36	Ungated outlets (No - size - invert elev. -ft. MSL)	2 - 2.0' x 4.0' 1,121 2 - 2.5' x 9.0' 1,127.5	2 - 1.0' x 2.5' 1,104.0 2 - 2.0' x 6.0' 1,109.0	2 - 1.5' x 3.5' 1,110.0 2 - 3.15' x 8.0' 1,117.6	2 - 1.25' x 3.5' 1,095.83 2 - 3.67' x 8.0' 1,103.4
37	**POWER INSTALLATION**	none	none	none	none

(1) Cost as of 5-3-88

(2) Based on a survey of July 1987 the elevation of the overflow lip was changed from 1096.0 ft. MSL to 1095.83 ft. MSL.

January 1995

PLATE 3

SUMMARY OF ENGINEERING DATA - FEDERAL RESERVOIRS WITH AUTHORIZED FLOOD CONTROL
MISSOURI RIVER TRIBUTARIES - U.S. ARMY ENGINEER DISTRICT - OMAHA
CORPS OF ENGINEERS DAMS - SALT CREEK BASIN, NEBRASKA

ITEM NO	SUBJECT	DAM NO. 2 (Olive Creek Lake)	DAM NO. 4 (Blue Stem Lake)	DAM NO. 8 (Wagon Train Lake)	DAM NO. 9 (Stagecoach Lake)	DAM NO. 10 (Yankee Hill Lake)
	GENERAL					
1	Location of dam	1.5 mi. W of Sprague	2.5 mi. W of Sprague	1.5 mi. N of Holland	1 mi. S of Hickman	3.5 mi. N of Denton
2	River and mileage	S Trib. of Olive Br. RM 12	N. Trib. of Olive Br. RM 9.5	N. Trib. of Hickman Br. RM .8	S. Trib. of Hickman Br. RM 1	Cardwell Br. RM 4
3	Drainage area in square miles	8.2	16.6	15.6	9.7	8.4
4	Reservoir length in miles	1.2	1.6	1.8	1.4	0.7
5	Location of Damtender	Missouri River Project Office	Missouri River Project Office	Missouri River Project Office	Missouri River Project Office	Missouri River Project Office
6	Travel time to Lincoln, NE	23 hrs.	13 hrs.	14 hrs.	8 hrs.	3 hrs.
7	Max. discharge of record	179 cfs July 1993	342 cfs October 1973	334 cfs July 1993	190 cfs October 1973	145 cfs October 1973
8	Max. pool elevation of record	1342.62 July 1993	1316.5 October 1973	1295.4 October 1973	1279.0 October 1973	1252.3 October 1973
9	Project cost	(1)	(1)	(1)	(1)	(1)
	DAM AND EMBANKMENT					
9	Top of dam - ft. MSL (2)	1359.0	1332.7	1311.2	1294.2	1270.2
10	Length of dam - ft.	3020.0	2460.0	1650.0	2250.0	3100.0
11	Height of dam - ft.	45.0	57.0	52.0	48.0	52.0
12	Stream bed - ft. MSL	1314.0	1277.0	1260.0	1246.0	1218.0
13	Abutment formation	Clay - sand - silt	Clay - sand	Clay	Clay - sand	Clay - sand
14	Type of fill	Rolled earth	Rolled earth	Rolled earth	Rolled earth	Rolled earth
15	Fill quantity in cu. yds.	312,000	471,000	376,000	374,000	502,000
16	Date of closure	20 Sept. 1963	12 Sept. 1962	24 Sept. 1962	27 Aug. 1963	5 Oct. 1965
17	Date of initial fill	30 Jun. 1965	6 Jul. 1963	24 Jun. 1963	25 May 1965	10 Jun. 1967
	SPILLWAY					
18	Discharge capacity – cfs	15,875 at el. 1357.1	22,925 at el. 1331.7	23,210 at el. 1309.8	17,565 at el. 1291.6	12,100 at el. 1267.8
19	Crest elevation - ft. MSL (2)	1350.0	1322.8	1301.2	1284.9	1262.5
20	Width - ft.	340.0	340.0	430.0	430.0	400.0
21	Gates, number, size, type	Ungated earth channel	Ungated earth channel	Ungated earth channel	Ungated earth channel	Ungated earth channel
	RESERVOIR ELEVATION AND AREA	(1993 data)	(1993 data)	(1987 data)	(1990 data)	(1994 data)
22	Maximum pool	1357.1 459A	1331.7 938A	1309.8 908A	1291.6 621A	1267.8 627A
23	Top of flood control pool	1350.0 359A	1322.5 646A	1302.0 648A	1285.0 464A	1262.0 495A
24	Top of joint use pool	none	none	none	none	none
25	Top of conservation pool	1335.0 162A	1307.4 309A	1287.8 277A	1271.1 195A	1244.9 211A
26	Top of sediment pool	1335.0 162A	1306.1 282A	1284.6 200A	1271.1 195A	1241.9 170A
	STORAGE ZONES (Elev. - Capacity)	(1993 data)	(1993 data)	(1987 data)	(1990 data)	(1994 data)
27	Surcharge zone	1350.0 - 1357.1 2,911AF	1322.5 - 1331.7 7,229AF	1302.0 - 1309.8 5,972AF	1285.0 - 1291.6 3,578AF	1262.0 - 1267.8 3,225AF
28	Exclusive flood control zone	1335.0 - 1350.0 3,857AF	1307.4 - 1322.5 7,129AF	1287.8 - 1302.0 6,676AF	1271.1 - 1285.0 4,413AF	1244.9 - 1262.0 5,841AF
29	Conservation zone	none	1306.1 - 1307.4 385AF	1284.6 - 1287.8 755AF	none	1241.9 - 1244.9 570AF
30	Sediment pool zone	1314.0 -1335.0 1,100AF	1277.0 - 1305.1 2,146AF	1260.0 - 1284.6 1,298AF	1246.0 - 1271.1 1,451AF	1218.0 - 1241.9 1,057AF
31	Gross Storage (Excl of surcharge)	4,957AF	9,660AF	8,929AF	5,864AF	7,468AF
	OUTLET WORKS					
32	Number and size – conduits	1 - CMP - 48" Dia. With 30" RCP lining	1 - CMP - 60" Dia. With 42" RCP lining	1 - CMP - 60" Dia. With 42" RCP lining	1 - CMP - 48" Dia. With 30" RCP lining	1 - CMP - 42" Dia. With 30" RCP lining
33	Conduit length - ft.	280	313	299	280	300
34	Gated outlets (No. - size - type - invert. elev.)	1 - 36" x 36" Lift gate- 1330.0	1 - 36" x 36" Lift gate- 1303.0	1 - 36" x 36" Lift gate- 1283.5	1 - 36" x 36" Lift gate- 1261.0	1 - 36" x 36" Lift gate- 1237.0
35	Ungated outlets (Openings - size - elev.)	2 - 24" x 72" - 1340.9 2 - 12" x 30" - 1335.0	2 - 30" x 96" - 1313.5 2 - 12" x 54" - 1307.4	2 - 30" x 96" - 1292.4 2 - 12" x 54" - 1287.8	2 - 24" x 72" - 1277.1 2 - 12" x 30" - 1271.1	2 - 18" x 63" - 1250.0 2 - 12" x 30" - 1244.9
36	Disch. capacity - cfs (At base of EFC zone)	85 @ 1335.0	85 @ 1307.4	85 @ 1287.8	85 @ 1271.1	110 @ 1244.9
37	**POWER INSTALLATION**	none	none	none	none	none

(1) Total project financial cost including all dams = $12,075,000 (Costs are as of 9-30-80)
(2) Top of dam and spillway crest elevation changed per 1997 Freeboard Analysis Surveys.

January 1995

PLATE 4

SUMMARY OF ENGINEERING DATA - FEDERAL RESERVOIRS WITH AUTHORIZED FLOOD CONTROL
MISSOURI RIVER TRIBUTARIES - U.S. ARMY ENGINEER DISTRICT - OMAHA
CORPS OF ENGINEERS DAMS - SALT CREEK BASIN, NEBRASKA

ITEM NO	SUBJECT	DAM NO. 12 (Conestoga Lake)	DAM NO. 13 (Twin Lakes)	DAM NO. 14 (Pawnee Lake)	DAM NO. 17 (Holmes Lake)	DAM NO. 18 (Branched Oak Lake)
	GENERAL					
1	Location of dam	1.5 mi. N of Denton	2 mi. NW of Pleasantdale	2 mi. NW of Emerald	SE edge of Lincoln	4 mi. W of Raymond
2	River and mileage	Holmes Cr. RM 1	Middle Cr. RM 12.8	N Middle Cr. RM 1	Antelope Cr. RM 6.1	Oak Cr. RM 17.3
3	Drainage area in square miles	15.1	11.0	35.9	5.4	88.7
4	Reservoir length in miles	1.4	1.5	3.0	0.7	3.7
5	Location of Damtender	Missouri River Project Office	Missouri River Project Office	Missouri River Project Office	Missouri River Project Office	Missouri River Project Office
6	Travel time to Lincoln, NE	8 hrs.	13 hours	7 hrs.	3 hrs.	6 hrs.
7	Max. discharge of record	185 cfs March 1987	168 cfs June 1983	419 cfs March 1987	187 cfs June 1983	774 cfs July 1993
8	Max. pool elevation of record	1241.1 March 1987	1346.9 June 1983	1249.9 July 1993	1249.97 July 1993	1287.9 August 1987
9	Project cost	(1)	(1)	(1)	(1)	(1)
	DAM AND EMBANKMENT					
9	Top of dam - ft. MSL (2)	1260.2	1363.6	1270.6	1271.3	1318.2
10	Length of dam - ft.	3000.0	2075.0	5000.0	7700.0	5200.0
11	Height of dam - ft.	63.0	58.0	65.0	55.0	70.0
12	Stream bed - ft. MSL	1197.0	1306.0	1206.0	1218.0	1250.0
13	Abutment formation	Clay - sand	Clay - sand - silt	Clay - sand	Clay - sand	Clay - sand - silt
14	Type of fill	Rolled earth	Rolled earth	Rolled earth	Rolled earth	Rolled earth
15	Fill quantity in cu. yds.	658,000	610,000	870,000	900,000	246,000
16	Date of closure	24 Sept. 1963	26 Sept. 1965	16 Jul. 1964	17 Sept. 1962	21 Aug. 1967
17	Date of initial fill	May 1965	18 Mar. 1969	21 Jun. 1967	2 Jun. 1965	18 Jan. 1973
	SPILLWAY					
18	Discharge capacity - cfs	27,220 at el. 1258.2	25,200 at el. 1361.6	19,875 at el. 1269.1	800 at el. 1269.7	7,825 at el. 1317.5
19	Crest elevation - ft. MSL (2)	1251.9	1354.9	1263.4	1267.2	1311.6
20	Width - ft.	750.0	400.0	700.0	50.0	200.0
21	Gates, number, size, type	Ungated earth channel	Ungated earth channel	Ungated earth channel	Ungated earth channel	Ungated earth channel
	RESERVOIR ELEVATION AND AREA	(1988 data)	(1994 data)	(1981 data)	(1993 data)	(1991 data)
22	Maximum pool	1258.2 733A	1361.6 636A	1269.1 1679A	1269.7 423A	1317.3 4224A
23	Top of flood control pool	1252.0 601A	1355.0 497A	1263.5 1403A	1266.0 381A	1311.0 3673A
24	Top of joint use pool	none	none	none	none	none
25	Top of conservation pool	1232.9 217A	1341.0 236A	1244.3 739A	1242.4 123A	1284.0 1847A
26	Top of sediment pool	1232.9 217A	1337.4 177A	1244.3 739A	1240.0 99A	1275.7 1225A
	STORAGE ZONES (Elev. - Capacity)	(1988 data)	(1994 data)	(1981 data)	(1993 data)	(1991 data)
27	Surcharge zone	1252.0 - 1258.2 4,141AF	1355.0 - 1361.6 3,728AF	1263.5 - 1269.1 8,575AF	1266.0 - 1269.7 1,490AF	1311.0 - 1317.3 24,886AF
28	Exclusive flood control zone	1232.9 - 1252.0 7,655AF	1341.0 - 1355.0 5,021AF	1244.3 - 1263.5 20,299AF	1242.4 - 1266.0 5,845AF	1284.0 - 1311.0 71,686AF
29	Conservation zone	none	1337.4 - 1341.0 747AF	none	1240.0 - 1242.4 245AF	1275.7 - 1284.0 12,724AF
30	Sediment pool zone	1197.0 - 1232.9 1,912AF	1306.0 - 1337.4 1,414AF	1206.0 - 1244.3 7,813AF	1218.0 - 1240.0 538AF	1250.0 - 1275.7 12,364AF
31	Gross Storage (Excl of surcharge)	9,567AF	7,182AF	28,112AF	6,628AF	96,774AF
	OUTLET WORKS					
32	Number and size - conduits	1 - CMP - 60" Dia. With 42" RCP lining	1 - CMP - 42" Dia. With 30" RCP lining	1 - CMP - 60" Dia. With 42" RCP lining	1 - CMP - 60" Dia. With 42" RCP lining	1 - CMP - concrete Lined - 72" Dia.
33	Conduit length - ft.	318	335	382	320	370
34	Gated outlets (No. - size - type - invert. elev.)	1 - 36" x 36" Lift gate- 1228.0	1 - 42" x 54" Lift gate- 1333.0	1 - 42" x 60" Lift gate- 1236.0	1 - 36" x 36" Lift gate- 1239.0	1 - 48" x 72" Lift gate - 1274.0
35	Ungated outlets (Openings - size - elev.)	2 - 30" x 96" - 1242.3 2 - 12" x 54" - 1232.9	2 - 24" x 63" - 1341.0 -	2 - 34" x 120" - 1244.3 -	2 - 30" x 96" - 1249.0 2 - 12" x 36" - 1242.5	1 - 10" Dia. slide gate- 1276.3 2 - 42" x 144" - 1283.95
36	Disch. capacity - cfs (At base of EFC zone)	85 @ 1232.9	190 @ 1341.0	210 @ 1244.3	85 @ 1242.4	300 @ 1284.0
37	**POWER INSTALLATION**	none	none	none	none	none

(1) Total project financial cost including all dams = $12,075,000 (Costs are as of 9-30-80)
(2) Top of dam and spillway crest elevation changed per 1997 Freeboard Analysis Surveys.

January 1995

PLATE 5

SUMMARY OF ENGINEERING DATA - FEDERAL RESERVOIRS WITH AUTHORIZED FLOOD CONTROL
MISSOURI RIVER TRIBUTARIES - U.S. ARMY ENGINEER DISTRICT - OMAHA
CORPS OF ENGINEERS DAMS - SOUTH DAKOTA

ITEM NO	SUBJECT	CEDAR CANYON	COLD BROOK	COTTONWOOD SPRINGS	SPRING CREEK(2) LAKE POCASSE
	GENERAL				
1	Location of dam	3.5 mi. W of Rapid City, SD	1 mi. N of Hot Springs, SD	4.5 mi. W of Hot Springs, SD	Pollock, SD
2	River and mileage	Deadman's Gulch	Cold Brook R M 1	Cottonwood Springs Creek	Spring Creek
3	Drainage area in square miles	0.4	70.5	26	660
4	Reservoir length in miles	Normally dry	1.2 at elevation 3646.5	0.6 mi. at elevation 3875	
5	Location of Damtender	Oahe Dam	On site	At Cold Brook Dam	Oahe Dam
6	Travel time to Missouri River	-	-	-	-
7	Max. discharge of record	440 cfs August 1949	8,400 cfs September 1938	-	-
8	Project cost (1)	$122,600	$1,571,000	$2,885,000	
	DAM AND EMBANKMENT				
9	Top of dam - ft. MSL	3554.0	3675.0	3955.0	1625.0
10	Length of dam - ft.	1,320	925	1,190	3,200
11	Height of dam - ft.	42	127	123	40
12	Stream bed - ft. MSL	3,512	3,545	3,832	1,585
13	Abutment formation	Minnekahta limestone	Sandstone, shale, limestone	Minnekahta limestone	
14	Type of fill	Rolled earth	Rolled earth	Rolled earth	Rolled earth
15	Fill quantity in cu. yds.	150,000	1,072,000	950,000	
16	Date of closure	September 1959	September 1952	May 1969	1961
17	Date of initial fill	-	June 1963 (3584.7)	-	Between 1961 and 1964
	SPILLWAY				
18	Discharge capacity - cfs (max. pool)	1,400 cfs at elevation 3550.6	80,600 cfs at el. 3667.2	39,600 cfs at el. 3950.3	
19	Crest elevation - ft. MSL	3545.0	3646.5	3936.0	1617.0
20	Width - ft.	60	200	275	72
21	Gates, number, size, type	Ungated rock channel	Ungated sharp crested weir	Ungated broad weir	Ungated box culverts
	RESERVOIR ELEVATION AND AREA				
22	Maximum pool	3550.6 15A	3667.2 279A	3950.0 257A	1625.0 2,560A
23	Top of flood control pool	3545.0 11A	3651.4 198A	3936.0 214A	-
24	Top of multipurpose pool	none	3585.0 36A	3875.0 41A	1617.0 1,520A
25	Top of inactive pool	3526.0 2A	none	3868.0 30A	1602.0 60A
	STORAGE ZONES (Elev. - Capacity)				
26	Surcharge	3545.0 - 3550.6 74AF	3651.4 - 3667.2 3,600AF	3936.0 - 3950.0 3,250AF	1617.0 - 1625.0 15,000AF
27	Flood control	3526.0 - 3545.0 123AF	3585.0 - 3651.4 6,680AF	3875.0 - 3936.0 7,730AF	
28	Multipurpose	none	3548.0 - 3585.0 520AF	3868.0 - 3875.0 249AF	1585.0 - 1617.0 11,000AF
29	Inactive	3512.0 - 3526.0 13AF	none	3832.0 - 3668.0 406AF	
30	Gross Storage (Excl of surcharge)	136AF	7,200AF	8,385AF	11,000AF
	OUTLET WORKS				
31	Number and size - conduits	1 - 24 in. C. M. P.	1 - 6.67 ft. conduit 1 - 8 in. supply line	1 - 48 in. concrete	1 - 5 ft. CMP
32	Conduit length - ft.	230	907	580	
33	Disch capacity of conduit - cfs(at top of FC Pool)	49 cfs at el. 3545	1540 cfs at el. 3651.4	560 cfs at el. 3936.0	
34	Gated outlets (No - size - invert. elev. of intake)	Ungated inlet - el. 3526	Ungated drop inlet - el. 3585 3 - 12 in. gate valves el. 3548 1 - 8 in. valve	Ungated drop inlet - el. 3875 1 - 3 x 3 ft. gate - el. 3868	5 x 5 ft sluice gate el. 1602 5 x 12 ft overflow roller gate el. 1609
35	Disch capacity of gated outlets - cfs				
36	Ungated outlets (No - size - invert elev. -ft. MSL)				
37	**POWER INSTALLATION**	none	none	none	none

(1) Cost as of 5-3-88

(2) Subimpoundment of Oahe Reservoir - no autihorized flood control.

January 1995

PLATE 6

SUMMARY OF ENGINEERING DATA - FEDERAL RESERVOIRS WITH AUTHORIZED FLOOD CONTROL
MISSOURI RIVER TRIBUTARIES - U.S. ARMY ENGINEER DISTRICT - OMAHA
CORPS OF ENGINEER DAMS - NORTH DAKOTA, MONTANA

ITEM NO	SUBJECT	BOWMAN HALEY	PIPESTEM	SNAKE CREEK LAKE AUDUBON (3)	BULL HOOK-SCOTT COULEE
	GENERAL				
1	Location of dam	6 mi. W of Haley, ND	3 mi. N W Jamestown, ND	12 mi. NE of Garrison Dam	1 mi. S of Havre, MT
2	River and river mile	N. Fk. Grand R M 100	Pipestem Creek R M 3	Snake Creek	Bull Hook Cr.-Scott Coulee
3	Drainage area (sq. mi.)	446	594	250	54
4	Reservoir length (mi.)	2.5 mi. at elevation 2755	5.5 at elevation 1442.4		Normally dry
5	Location of Damtender	Garrison Dam	On site	Garrison Dam	Ft. Peck Dam
6	Travel time to Missouri River	1 day to Shadehill Dam	8 weeks	-	-
7	Max. discharge of record	14,100 cfs April 1952	6,080 cfs April 1969		-
8	Project cost (1)	$4,372,200	$9,277,500		$1,837,200
	DAM AND EMBANKMENT				
9	Top of dam - ft. MSL	2794.0	1507.5	1865	2613.3 (BH) 2613.3 (SC)
10	Length of dam - ft.	5,730	4,000	12,900	1,900 (BH) 1500 (SC)
11	Height of dam - ft.	79	107.5	85	73 (BH) 53 (SC)
12	Stream bed - ft. MSL	2715	1,400	1780	2,540 (BH) 2,560 (SC)
13	Abutment formation	Ludlow, sandy clay, silty sand	Sandy overburden-P. shale		Glacial till, lean clay
14	Type of fill	Rolled earth	Rolled earth	Rolled Earth	Rolled earth
15	Fill quantity in cu. yds.	1,750,000	1,990,000		1,300,000
16	Date of closure	August 1966	July 1973	1952	October 1955
17	Date of initial fill (base F.C.)	March 1969	May 1974	September 1975	-
	SPILLWAY				*Notch in BH to 2583
18	Discharge capacity - cfs	62,970 cfs at elevation 2789	56,200 cfs at el. 1502.8	none	25,200 cfs at elevation 2605
19	Crest elevation - ft. MSL	2,777	1496.3		2593.0 (BH)* 2586.0 (SC)
20	Width - ft.	650	1500		-
21	Gates, number, size, type	Ungated earth notch (2)	Ungated earth channel		Ungated earth channels
	RESERVOIR ELEVATION AND AREA				
22	Maximum pool	2789.0 7916a	1502.8 6000a	1850 20,620a	2605.0 (BH & SC) 384a
23	Top of flood control pool	2777.0 5131a	1496.3 4728a	none	2593.0 (BH & SC) 283a
24	Top of multipurpose pool	2754.8 1732a	1442.5 840a	1847 18,780a	none
25	Top of inactive pool	2740.0 565a	1415.0 5a	1810 1,450a	none
	STORAGE ZONES (Elev. - Capacity)				Total - (BH & SC)
26	Surcharge	2777.0 - 2789.0 77,085AF	1496.3 - 1502.8 34,681AF	1847 - 1850 59,130AF	2593.0 - 2605.0 4000AF
27	Flood Control	2754.8 - 2777.0 72,717AF	1442.5 - 1496.3 133,163AF	none	2540.0 - 2593.0 6500AF
28	Multipurpose	2740.0 - 2754.8 15,456AF	1415.0 - 1442.5 8,944AF	1810 - 1847 323,690AF	none
29	Inactive	2715.0 - 2740.0 3,309AF	1400.0 - 1415.0 0AF	1780 - 1810 13,180AF	none
30	Gross (top of flood control pool)	91,482AF	142,107AF	396,000AF	6500AF
	OUTLET WORKS				
31	Number and size - conduits	1 - 10 ft. circular conduit	1 - 8 ft. circular conduit	1 - 7 x 10 ft. reinforced concrete conduit	1 - 30 in. RCP - Bull Hook 1 - 30 in. RCP - Scott Coulee
32	Conduit length - ft.	341 ft. Ungated Glory Hole-el 2754.8	675 ft. Ungated drop inlet-el. 1442.5	1 - 7 x 10 ft. sluice gate	393 ft. - Bull Hook 286 ft. - Scott Coulee
33	Number - size - type gates	2 - 30 in. valves - el. 2740.0 1 - 30 in. interior gate valve 1 - 30 in. interior slide gate	2 - 4 x 7 ft. hydraulic slide 1 - 36 in valve, 1-3 x 3 ft slide		1 - 24 in. valve, Bull Hook 1 - 24 in. valve, Scott Coulee
34	Discharge capacity	Glory Hole-3206cfs at el 2789 30 in. valve-140cfs at el 2755	2,300 cfs at el. 1496.3	2,300 cfs at 15 ft. head differential	123 cfs at 2593- Bull Hook 103 cfs at 2593- Scott Coulee
35	**POWER INSTALLATION**	none	None	none	none

(1) Costs are as of 9-30-80.
(2) Bowman Haley Spillway equipped with Fuse Plug (Crest Elevation 2780.7 ft MSL).
(3) Subimpoundiment of Garrison Reservoir - no authorized flood control.

January 1995

PLATE 7

SUMMARY OF ENGINEERING DATA - FEDERAL RESERVOIRS WITH AUTHORIZED FLOOD CONTROL
MISSOURI RIVER TRIBUTARIES - U.S. ARMY ENGINEER DISTRICT - OMAHA
BUREAU OF RECLAMATION DAMS

ITEM NO	SUBJECT	BOYSEN	CANYON FERRY	CLARK CANYON	GLENDO	HEART BUTTE
	GENERAL					
1	Location of dam	20 mi S of Thermopolis,Wy	17 mi NE of Helena, MT	18 mi SW of Dillon, MT	4.5 mi SE of Glendo, WY	15 mi S of Glen Ullin, ND
2	River and river mile	Wind RM 295	Missouri RM 2253	Beaverhead	North Platte RM 280	Heart RM 103.5
3	Drainage area (sq. mi.)	7710	15900	2320	14330	1710
4	Reservoir length (mi.)	17.5 at el. 4725	25 at el. 3800	5 at el. 5560.4	15 at el. 4635	12 at el. 2094.5
5	Location of Damtender	On site	On site	Dillon, MT	On site	On site
6	Travel time to Missouri River	6 days	4.5 days to Ft. Peck	2.5 days to Three Forks	About 3 weeks	2 days
7	Max. discharge of record	29,800 cfs Jul 1923	47,000 cfs Jun 1908	3720 cfs Jun 1908	30,000 cfs Jun 1908	30,500 cfs May 1970
8	Project cost (1)	$33,468,000	$42,546,000	$12,108,000	$44,371,000	$3,576,000
	DAM AND EMBANKMENT					
9	Top of dam - ft. MSL	4758.0	3808.5	5578.0	4675.0	2124.0
10	Length of dam - ft.	1143	1000	2950	2096	1850
11	Height of dam - ft.	150	225	147.5	167	124
12	Stream bed - ft. MSL	4608	3635.5	5446.5	4508	2000
13	Abutment formation	Sandstone-shale-limestone	Shale - slate	Sand - bentonitic tuff	Sandstone - shale	Sandstone
14	Type of fill	Rolled earth	Concrete gravity	Rolled earth	Rolled earth	Rolled earth
15	Fill quantity in cu. yds.	1,527,000	407,100	1,884,000	2,676,000	1,140,000
16	Date of closure	Oct 1951	Mar 1953	Aug 1964	Jun 1956	Aug 1949
17	Date of initial fill (top ofconser. pool)	Jun 1952	Jul 1955	Jun 1965	May 1959	Apr 1950
	SPILLWAY					
18	Discharge capacity - cfs (Max. pool)	20,000 at el. 4725	150,000	9530	10,300	5650
19	Crest elevation - ft. MSL	4700.0	3766.0	5560.4	4653.0	2064.5
20	Width - ft.	60 (net) 68 (total)	204 (net) 222 (gross)	100	45	27
21	Gates, number, size, type	2 (30 x 25 ft) radial	4 (51 x 34.5 ft) radial	Ungated chute	Ungated ogee weir	Ungated glory hole
	RESERVOIR ELEVATION AND AREA					
22	Maximum pool	4752.0 30,860a	3800.0 33,535a	5571.9 6600a	4669.0 23,300a	2118.2 10,950a
23	Top of flood control pool	4732.2 22,170a	3800.0 33,535a	5560.4 5900a	4653.0 17,990a	2094.5 6,580a
24	Top of joint use pool	4725.0 19,560a	3797.0 32,800a	5546.1 5160a	-	-
25	Top of conservation pool	4717.0 16,960a	3770.0 24,125a	5535.7 4495a	4635.0 12,370a	2064.5 3,400a
26	Top of inactive pool	4685.0 9,280a	3728.0 11,480a	5470.6 220a	4570.0 3,130a	2030.0 800a
	STORAGE ZONES (Elev. - Capacity)					
27	Surcharge zone	4732.2-4752.0 520,700AF	none	5560.4-5571.0 71,830AF	4653.0-4669.0 329,300AF	2094.5-2118.2 206,400AF
28	Exclusive flood control zone	4725.0-4732.2 150,400AF	3797.0-3800.0 99,460AF	5546.1-5560.4 79,090AF	4635.0-4653.0 271,900AF	2064.5-2094.5 147,900AF
29	Joint use zone	4717.0-4725.0 146,100AF	3770.0-3797.0 795,135AF	5535.7-5546.1 50,440AF	none	none
30	Conservation zone	4685.0-4717.0 403,800AF	3728.0-3770.0 711,460AF	5470.6-5535.7 126,120AF	4570.0-4635.0 454,300AF	2030.0-2064.5 69,000AF
31	Inactive zone	4608.0-4685.0 252,100AF	2635.5-3728.0 445,455AF	2446.5-5470.6 1,510AF	4508.0-4570.0 63,200AF	2000.0-2030.0 6,800AF
32	Gross Storage (Excl. of surcharge)	952,400AF	2,051,520AF	257,150AF	789,400AF	223,600AF
	OUTLET WORKS					
33	Number and size - conduits	1 - 66 in. I.D. 1 - 57 in. I.D.	4 - 84 in. I.D. 1 - 13 ft. I.D. pump intake	1 - 9 ft. I.D.	1 - 21 ft. I.D.	1 - 63 in. I.D.
34	Conduit length - ft.	300	84 in. - 115	741	2300	597
35	Number - size - type gates	2 - 48 in. Jet valves	4 - 77 in. Slide 9500	2 - 3 x 6.5 ft. Slide	3 - 7.25 x 7.75 ft. Slide	1 - 4 x 5 ft. Slide
36	Disch. capac. - cfs (At base of EFC zone)	66 in. - 640 57 in. - 670	1 - 13 ft. dia. 600 3 - 13.5 ft. dia. 5970	2200	11,300	690
	POWER INSTALLATION					
37	No. and size of turbines	2 - 10,500 HP	3 - 23,500 HP		2 - 16,750 HP	
38	No. and rating of generators	2 - 7500 kW	3 - 16,667 KW	none	2 - 12,000 KW	none
39	Plant capacity	15,000 KW	50,000 KW		24,000 KW	
40	Power Plant disch. capac.(At base of EFC)	5200 cfs	5200 cfs		3300 cfs	

(1) These costs to complete the dam and reservoir, the associated recreation and fish and wildlife facilities and the power plant are applicable. January 1995
Costs do not include irrigation facilities except those located at the dam. Costs are as of 6-30-76.

(2) TIBER AUXILIARY OUTLET

No. and size of conduits	1 - 10.75 ft. I.D.
Conduit length - ft.	1535
No. - Size - Type gates	1 - 7.25 x 9.25 ft. slide 2 - 7.0 x 12.0 ft. slide
Discharge capacity - cfs	4250 at el. 3020.2

(3) Pactola Dam was raised 15 feet in 1987

SUMMARY OF ENGINEERING DATA - FEDERAL RESERVOIRS WITH AUTHORIZED FLOOD CONTROL
MISSOURI RIVER TRIBUTARIES - U.S. ARMY ENGINEER DISTRICT - OMAHA
BUREAU OF RECLAMATION DAMS

ITEM NO	SUBJECT	JAMESTOWN	KEYHOLE	PACTOLA	SHADEHILL	TIBER	YELLOWTAIL
	GENERAL						
1	Location of dam	1 mi N of Jamestown, ND	12 mi NE of Moorcroft, WY	15 mi W of Rapid City, SD	1 mi W of Shadehill, SD	15 mi SW of Chester, MT	45 mi SW of Hardin, MT
2	River and river mile	James RM 580	Belle Fourche RM 289	Rapid Cr. RM 110	Grand RM 90	Marias RM 71	Bighorn
3	Drainage area (sq. mi.)	1300	1950	319	3120	4850	19,626
4	Reservoir length (mi.)	40 at el. 1454	10 at el. 4111.4	4.5 at el. 4621.5	10 at el. 2302	25 at el. 3012.5	71 at el. 3657
5	Location of Damtender	none	Pactola Dam	On site	none	On site	On site
6	Travel time to Missouri River	About 7 weeks	5 days	3 days	2 days	1.25 days	4 days
7	Max. discharge of record	± 8000 cfs Apr 1969	12,000 cfs Apr 1924	2200 cfs May 1952	58,000 cfs Apr 1950	40,000 cfs Jun 1948	37,400 cfs Jun 1935
8	Project cost (1)	$3,717,000	$4,722,000	$7,861,000	$7,269,000	$44,909,000 (1983)	$95,900,000
	DAM AND EMBANKMENT						
9	Top of dam - ft. MSL	1471.0	4134.0	4655.0 (3)	2318.0	3026.0	3660.0
10	Length of dam - ft.	1418	3420	5290	12,840	4300	1450
11	Height of dam - ft.	85	118	245	122	201	524
12	Stream bed - ft. MSL	1386	4016	4422	2196	2823.5	3166
13	Abutment formation	Pierre shale	Sandstone and shale	Slate and schist	Sand, silt and clay	Shale and sandstone	Limestone
14	Type of fill	Rolled earth	Rolled earth and rock	Rolled earth and rock	Rolled earth	Rolled earth	Concrete thin-arch
15	Fill quantity in cu. yds.	963,000	1,329,000	4,532,000	3,391,000	12,049,000	1,546,000
16	Date of closure	May 1953	Mar 1952	Aug 1956	Jul 1950	Oct 1950	Dec 1966
17	Date of initial fill (top ofconser. pool)	Apr 1965	May 1978	Jun 1963	Apr 1952	Aug 1956	Jun 1967
	SPILLWAY						
18	Discharge capacity - cfs (Max. pool)	2930	11000	255,000	(Service) 5700 127,000 cfs	68,470	92000
19	Crest elevation - ft. MSL	1454	4099.3	4621.5	2271.9 2302.0	2975.0	3593.0
20	Width - ft.	9.5	19.25	425	- 1500	66	50 (net)
21	Gates, number, size, type	Ungated glory hole	Ungated ogee weir	Ungated ogee weir	Ungated glory hole Ungated earth channel	3 - 22 x 38 ft. radial	2 - 25 x 64.4 ft. radial
	RESERVOIR ELEVATION AND AREA						
22	Maximum pool	1464.4 17,430a	4128.7 10,730a	4651.7 1,560a	2312.0 12,150a	3020.2 25,410a	3660.0 17,940a
23	Top of flood control pool	1454.0 13,210a	411.5 13,730a	4621.5 1,230a	2302.0 9,900a	3012.5 23,150a	3657.0 17,280a
24	Top of joint use pool	1432.67 2,560a	-	-	-	2993.0 17,890a	3640.0 12,600a
25	Top of conservation pool	1429.8 2,090a	4099.3 9,410a	4580.2 860a	2271.9 4,800a	2976.0 13,790a	3614.0 6,915a
26	Top of inactive pool	1400.0 160a	4051.0 820a	4456.1 100a	2250.8 2,800a	2966.4 11,710a	3547.0 4,150a
	STORAGE ZONES (Elev. - Capacity)						
27	Surcharge zone	1454.0-1464.4 158,900AF	4111.5-4128.7 294,800AF	4621.5-4651.7 41,892AF	2302.0-2312.0 111,200AF	3012.5-3020.2 187,740AF	3657.0-3660.0 52,830AF
28	Exclusive flood control zone	1432.7-1454.0 185,400AF	4099.3-4111.5 140,500AF	4580.2-4621.5 43,057AF	2271.9-2302.0 218,300AF	2993.0-3012.5 400,900AF	3640.0-3657.0 258,330AF
29	Joint use zone	1429.8-1432.7 6,600AF	none	none	none	2976.0-2993.0 268,000AF	3614.0-3640.0 240,340AF
30	Conservation zone	1400.0-1429.8 28,100AF	4051.0-4099.3 185,500AF	4456.1-4580.2 54,955AF	2250.8-2271.9 80,900AF	2966.4-2976.0 121,700AF	3547.0-3614.0 336,100AF
31	Inactive zone	1386.0-1400.0 820AF	4016.0-4051.0 8,000AF	4422.0-4456.1 1,017AF	2196.0-2250.8 58,200AF	2823.5-2966.4 577,620AF	3166.0-3547.0 493,580AF
32	Gross Storage (Excl. of surcharge)	221,000AF	334,200AF	99,029AF	357,400AF	1,555,960AF	1,328,360AF
	OUTLET WORKS						
33	Number and size - conduits	1 - 9.5 ft. - 13.5 ft.	1 - 9.5 x 8.25	1 - 6 ft.	1 - 7 ft. I.D.	1 conduit containing 1 - 72", 1 - 22" pipes	2 - 84 in. 1 - 9.5 ft.
34	Conduit length - ft.	443.75	653.4	740	355	72" - 1110 22"-1090	289 - 216 - 305
35	Number - size - type gates	2 - 5 x 6 ft. Slide	2 - 3.5 x 3.5 ft. Slide	2 - 2.75 x 2.75 ft. Slide	1 - 6 x 6 ft. radial	1-5x5' Slide, 1-18" butterfly	3 - bulkhead gates
36	Disch. capac. - cfs (At base of EFC zone)	2175 at el. 1429.8	1250	1020	600 at el. 2260	1425 at el. 2993 Aux. outlet, see footnote (2)	84 in. - 2500 each 9.5 ft. - 862
	POWER INSTALLATION						
37	No. and size of turbines						4 - 87,500 HP
38	No. and rating of generators	none	none	none	none	none	4 - 62,500 KW
39	Plant capacity						250,000 KW
40	Power Plant disch. capac.(At base of EFC)						7800 cfs

(1) These costs to complete the dam and reservoir, the associated recreation and fish and wildlife facilities and the power plant are applicable. Costs do not include irrigation facilities except those located at the dam. Costs are as of 6-30-76.

(2) TIBER AUXILIARY OUTLET

No. and size of conduits	1 - 10.75 ft. I.D.
Conduit length - ft.	1535
No. - Size - Type gates	1 - 7.25 x 9.25 ft. Slide 2 - 7.0 x 12.0 ft. slide
Discharge capacity - cfs	4250 at el. 3020.2

(3) Pactola Dam was raised 15 feet in 1987

January 1995

PLATE 9

Summary of Engineering Data - Missouri River Main Stem Reservoirs

Item No.	Subject	Fort Peck Lake	Garrison Dam - Lake Sakakawea	Oahe Dam - Lake Oahe	Big Bend Dam - Lake Sharpe	Fort Randall Dam - Lake Francis Case	Gavins Point Dam - Lewis & Clark Lake	Total	Item No.	Remarks
1	Location of Dam	Near Glasgow, Montana	Near Garrison, ND	Near Pierre, SD	21 miles upstream Chamberlain	Near Lake Andes, SD	Near Yankton, SD		1	(1) Includes 4,280 square miles of non-contributing areas.
2	River Mile - 1960 Mileage	Mile 1771.5	Mile 1389.9	Mile 1072.3	Mile 987.4	Mile 880.0	Mile 811.1		2	(2) Includes 1,350 square miles of non-contributing areas.
3	Total & incremental drainage areas in square miles	57,500	181,400 (2) 123,900	243,490 (1) 62,090	249,330 (1) 5,840	263,480 (1) 14,150	279,480 (1) 16,000		3	(3) With pool at base of flood control.
4	Approximate length of full reservoir (in valley miles)	134, ending near Zortman, MT	178, ending near Trenton, ND	231, ending near Bismarck, ND	80, ending near Pierre, SD	107, ending at Big Bend Dam	25, ending near Niobrara, NE	755 miles	4	(4) Storage first available for regulation of flows.
5	Shoreline in miles (3)	1520 (elevation 2234)	1340 (elevation 1837.5)	2250 (elevation 1607.5)	200 (elevation 1420)	540 (elevation 1350)	90 (elevation 1204.5)	5,940 miles	5	(5) Damming height is height from low water to maximum operating pool. Maximum height is from average streambed to top of dam.
6	Average total & incremental inflow in cfs	10,200	25,600 15,400	28,900 3,300	28,900	30,000 1,100	32,000 2,000		6	(6) Based on latest available storage data.
7	Max. discharge of record near damsite in cfs	137,000 (June 1953)	348,000 (April 1952)	440,000 (April 1952)	440,000 (April 1952)	447,000 (April 1952)	480,000 (April 1952)		7	(7) River regulation is attained by flows over low-crested spillway and through turbines.
8	Construction started - calendar yr.	1933	1946	1948	1959	1946	1952		8	(8) Length from upstream face of outlet or to spiral case.
9	In operation (4) cal. yr.	1940	1955	1962	1964	1953	1955		9	(9) Based on 8th year (1961) of drought drawdown (From study 8-83-1985).
	Dam and Embankment									(10) Affected by level of Lake Francis case. Applicable to pool at elevation 1350.
10	Top of dam elevation in feet msl	2280.5	1875	1660	1440	1395	1234		10	(11) Spillway crest.
11	Length of dam in feet	21,026 (excluding spillway)	11,300 (including spillway)	9,300 (excluding spillway)	10,570 (including spillway)	10,700 (including spillway)	8,700 (including spillway)	71,596	11	(12) 1967-1996 Average
12	Damming height in feet (5)	220	180	200	78	140	45	863 feet	12	(13) Source: Annual Report on Civil Works Activities of the Corps of Engineers. Extract Report Fiscal Year 1996.
13	Maximum height in feet (5)	250.5	210	245	95	165	74		13	
14	Max. base width, total & w/o berms in feet	3500, 2700	3400, 2050	3500, 1500	1200, 700	4300, 1250	850, 450		14	
15	Abutment formations (under dam & embankment)	Bearpaw shale and glacial fill	Fort Union clay shale	Pierre shale	Pierre shale & Niobrara chalk	Niobrara chalk	Niobrara chalk & Carlile shale		15	
16	Type of fill	Hydraulic & rolled earth fill	Rolled earth filled	Rolled earth fill & shale berms	Rolled earth, shale, chalk fill	Rolled earth fill & chalk berms	Rolled earth & chalk fill		16	
17	Fill quantity, cubic yards	125,628,000	66,500,000	55,000,000 & 37,000,000	17,000,000	28,000,000 & 22,000,000	7,000,000	358,128,000 cu. yds	17	
18	Volume of concrete (cubic yards)	1,200,000	1,500,000	1,045,000	540,000	961,000	308,000	5,554,000 cu. yds.	18	
19	Date of Closure	24 June 1937	15 April 1953	3 August 1958	24 July 1963	20 July 1952	31 July 1955		19	
	Spillway Data									
20	Location	Right bank - remote	Left bank - adjacent	Right bank - remote	Left bank - adjacent	Left bank - adjacent	Right bank - adjacent		20	
21	Crest elevation in feet msl	2225	1825	1596.5	1385	1346	1180		21	
22	Width (including piers) in feet	820 gated	1336 gated	456 gated	376 gated	1000 gated	664 gated		22	
23	No., size and types of gates	16 - 40' x 25' vertical lift gates	28 - 40' x 29' Tainter	8 - 50' x 23.5' Tainter	8 - 40' x 38' Tainter	21 - 40' x 29' Tainter	14 - 40' x 30' Tainter		23	
24	Design discharge capacity, cfs	275,000 at elev 2253.3	827,000 at elev 1858.5	304,000 at elev 1644.4	390,000 at elev 1433.6	620,000 at elev 1379.3	584,000 at elev 1221.4		24	
25	Discharge capacity at maximum operating pool in cfs	230,000	660,000	80,000	270,000	508,000	345,000		25	
	Reservoir Data (6)									
26	Max. operating pool elev & area	2250 msl 246,000 acres	1854 msl 380,000 acres	1620 msl 374,000 acres	1423 msl 61,000 acres	1375 msl 102,000 acres	1210 msl 31,000 acres	1,194,000 acres	26	
27	Max. normal op pool elev & area	2246 msl 240,000 acres	1850 msl 364,000 acres	1617 msl 360,000 acres	1422 msl 60,000 acres	1365 msl 95,000 acres	1208 msl 28,000 acres	1,147,000 acres	27	
28	Base flood control elev & area	2234 msl 212,000 acres	1837.5 msl 307,000 acres	1607.5 msl 312,000 acres	1420 msl 57,000 acres	1350 msl 77,000 acres	1204.5 msl 24,000 acres	989,000 acres	28	
29	Min. op. pool elev. & area	2160 msl 90,000 acres	1775 msl 128,000 acres	1540 msl 117,000 acres	1415 msl 51,000 acres	1320 msl 38,000 acres	1204.5 msl 24,000 acres	450,000 acres	29	
	Storage allocation & capacity									
30	Exclusive flood control	2250-2246 975,000 a.f.	1854-1850 1,489,000 a.f.	1620-1617 1,102,000 a.f.	1423-1422 60,000 a.f.	1375-1365 985,000 a.f.	1210-1208 59,000 a.f.	4,670,000 a.f.	30	
31	Flood control & multiple use	2246-2234 2,717,000 a.f.	1850-1837.5 4,222,000 a.f.	1617-1607.5 3,201,000 a.f.	1422-1420 117,000 a.f.	1365-1350 1,309,000 a.f.	1208-1204.5 90,000 a.f.	11,656,000 a.f.	31	
32	Carryover multiple use	2234-2160 10,785,000 a.f.	1837.5-1775 13,130,000 a.f.	1607.5-1540 13,461,000 a.f.		1350-1320 1,607,000 a.f.		38,983,000 a.f.	32	
33	Permanent	2160-2030 4,211,000 a.f.	1775-1673 4,980,000 a.f.	1540-1415 5,373,000 a.f.	1420-1345 1,682,000 a.f.	1320-1240 1,517,000 a.f.	1204.5-1160 321,000 a.f.	18,084,000 a.f.	33	
34	Gross	2250-2030 18,688,000 a.f.	1854-1673 23,821,000 a.f.	1620-1415 23,137,000 a.f.	1423-1345 1,859,000 a.f.	1375-1240 5,418,000 a.f.	1210-1160 470,000 a.f.	73,393,000 a.f.	34	
35	Reservoir filling initiated	November 1937	December 1953	August 1958	November 1963	January 1953	August 1955		35	
36	Initially reached min. operating pool	27 May 1942	7 August 1955	3 April 1962	25 March 1964	24 November 1953	22 December 1955		36	
37	Estimated annual sediment inflow	18,100 a.f. 1030 yrs.	25,900 a.f. 920 yrs.	19,800 a.f. 1170 yrs.	4,300 a.f. 430 yrs.	18,300 a.f. 250 yrs.	2,600 a.f. 180 yrs.	92,500 a.f.	37	
	Outlet Works Data									
38	Location	Right bank	Right Bank	Right Bank		Left Bank			38	
39	Number and size of conduits	2 - 24' 8" diameter (nos. 3 & 4)	1 - 26' dia. and 2 - 22' dia.	6 - 19.75' dia. upstream, 18.25' dia. downstream	None (7)	4 - 22' diameter	None (7)		39	
40	Length of conduits in feet (8)	No. 3 - 6,615, No. 4 - 7,240	1529	3496 to 3659		1013			40	
41	No., size, and type of service gates	1 - 28' dia. cylindrical gate 6 ports, 7.6' x 8.5' high (net opening) in each control shaft	1 - 18' x 24.5' Tainter gate per conduit for fine regulation	1 - 13' x 22' per conduit, vertical lift, 4 cable suspension and 2 hydraulic suspension (fine regulation)		2 - 11' x 23' per conduit, vertical lift, cable suspension			41	
42	Entrance invert elevation (msl)	2095	1672	1425	1385 (11)	1229	1180 (11)		42	
43	Avg. discharge capacity per conduit & total	Elev. 2250 22,500 cfs - 45,000 cfs	Elev. 1854 30,400 cfs - 98,000 cfs	Elev. 1620 18,500 cfs - 111,000 cfs		Elev 1375 32,000 cfs - 128,000 cfs			43	
44	Present tailwater elevation (ft msl)	2032-2036 5,000 - 35,000 cfs	1670-1680 ,000- 60,000 cfs	1423-1428 20,000-55,000 c	1351-1355(10) 25,000-100,000	1228-1239 5,000-60,000 cfs	1155-1163 5,000-60,000 cfs		44	
	Power Facilities and Data									
45	Avg. gross head avail in feet (14)	194	161	174	70	117	48	764 feet	45	
46	Number and size of conduits	No. 1-24'8" dia., No. 2-22'4" dia.	5 - 29' dia., 25' penstocks	7 - 24' dia., imbedded penstocks	None: direct intake	8 - 28' dia., 22' penstocks	None: direct intake		46	
47	Length of conduits in feet (8)	No. 1 - 5,653, No. 2 - 6,355	1829	From 3,280 to 4,005		1,074		55,083	47	
48	Surge tanks	PH#1: 3-40' dia., PH#2: 2-65' dia.	65' dia. - 2 per penstock	70' dia., 2 per penstock	None	59' dia, 2 per alternate penstock	None		48	
49	No., type and speed of turbines	5 Francis, PH#1-2: 128.5 rpm, 1-164 rpm , PH#2-2: 128.6 rpm	5 Francis, 90 rpm	7 Francis, 100 rpm	8 Fixed blade, 81.8 rpm	8 Francis, 85.7 rpm	3 Kaplan, 75 rpm	36 units	49	
50	Disch. cap. at rated head in cfs	PH#1, units 1&3 170', 2-140' 8,800 cfs, PH#2-4&5 170'-7,200 cfs	150' 41,000 cfs	185' 54,000 cfs	67' 103,000 cfs	112' 44,500 cfs	48' 36,000 cfs		50	
51	Generator nameplate rating in kW	1&3: 43,500; 2: 18,250; 4&5: 40,00	3 - 109,250, 2 - 95,000	112,290	3 - 67,276, 5 - 58,500	40,000	44,100		51	
52	Plant capacity in kW	185,250	517,750	786,030	494,320	320,000	132,300	2,435,650 kw	52	
53	Dependable capacity in kW (9)	181,000	388,000	534,000	497,000	293,000	74,000	1,967,000 kw	53	
54	Avg annual energy, million kWh (12)	1,162	2,442	2,832	1,033	1,820	747	10,034 million kWh	54	Corps of Engineers, U.S. Army
55	Initial generation, first and last unit	July 1943 - June 1961	January 1956 - October 1960	April 1962 - June 1963	October 1964 - July 1966	March 1954 - January 1956	September 1956 - January 1957	July 1943 - July 1966	55	Compiled by
56	Estimated cost September 1992 Completed project (13)	$158,428,000	$299,938,000	$346,521,000	$107,498,000	$199,066,000	$49,617,000	$1,161,068,000	56	Missouri River Division May 1997

PLATE 10

APPENDIX 1

PROJECT OPERATIONS SUMMARIES

CORPS OF ENGINEERS PROJECTS

BEAR CREEK DAM
SOUTH PLATTE RIVER BASIN, COLORADO
1997-1998 REGULATION

In response to the contracts for temporary water storage, a revised Memorandum of Understanding (MOU) between the Corps of Engineers and the State of Colorado was signed on June 20, 1988. This memorandum supercedes the previous MOU dated May 11, 1977. Under normal conditions the Bear Creek Dam outlet works is set to automatically pass streamflow up to 500 cfs when pool elevations are above the drop inlet-outlet weir crest of 5558.0 ft-msl. When conditions warrant, higher releases are made by opening two slide service gates in the dome-type gated control structure buried under the embankment. Under the revised MOU, the State Engineer or his representative will determine the storage and releases necessary to satisfy downstream water right requirements when the pool level is below elevation 5559.0 ft-msl. Elevation 5559.0 ft-msl is one foot into the flood storage zone and was selected to allow flexibility in targeting authorized pool levels. Bear Creek Reservoir was not made operational during the report period as has been done in the past. No contract water was stored during the report period.

The State of Colorado, Department of Natural Resources, Division of Game, Fish and Parks, in a letter dated October 1, 1970, agreed to provide water for the initial filling and replenishment of evaporation losses from the recreation pool, by purchase or other means, consistent with Federal and State laws to assure effective operation of the project for recreation.

Runoff during the report period was 212% of normal. Runoff peaked in May with 24,496 acre-feet of inflow to the project. A total of 1147 acre-feet or 4% of the 28,757 acre-feet flood storage zone was utilized at the maximum pool elevation of 5567.21 ft-msl on May 9, 1998.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	910 cfs May 01 80	800 cfs May 5-12 80
2nd	795 cfs Jun 10 95	800 cfs Jun 12 79
3rd	690 cfs Jun 10 79	612 cfs Jun 25

	Pool-Date
Highest	5587.17 Jun 17 95
2nd	5581.0 Jun 23 83
3rd	5576.3 May 19 80

Minimums of Record (since initial fill):

	Pool-Date
Lowest	5556.98 Feb 09 82
2nd	5557.08 Jul 09 86

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
79,673, 212% of normal

Total Outflow (AF)
79,291, 213% of normal

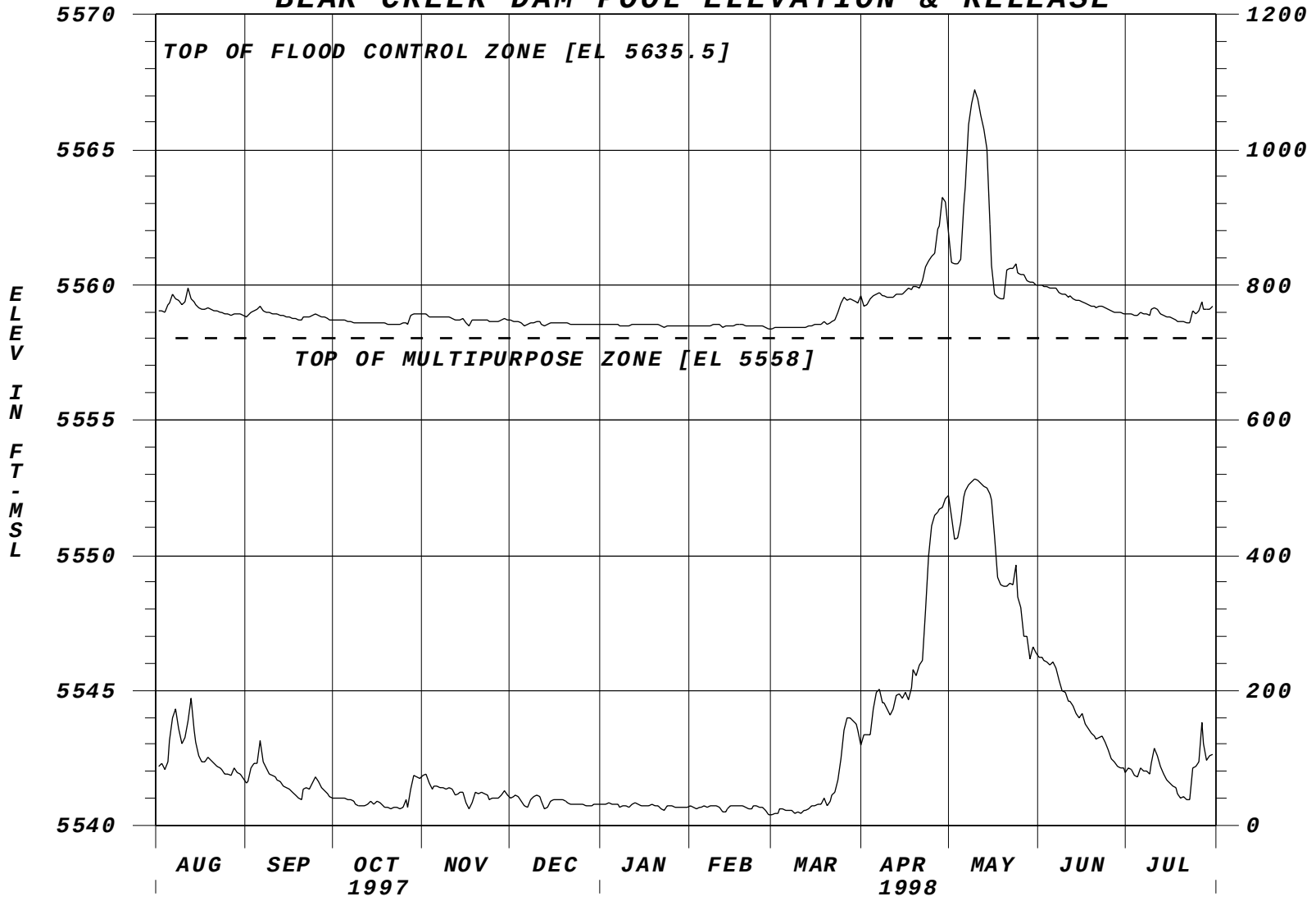
Peak Daily Inflow (CFS)
658, May 07

Peak Daily Outflow (CFS)
512, May 09

Peak Pool Elevation (FT-MSL)
5567.21, May 09

Minimum Pool Elevation (FT-MSL)
5558.38, Feb 27

BEAR CREEK DAM POOL ELEVATION & RELEASE

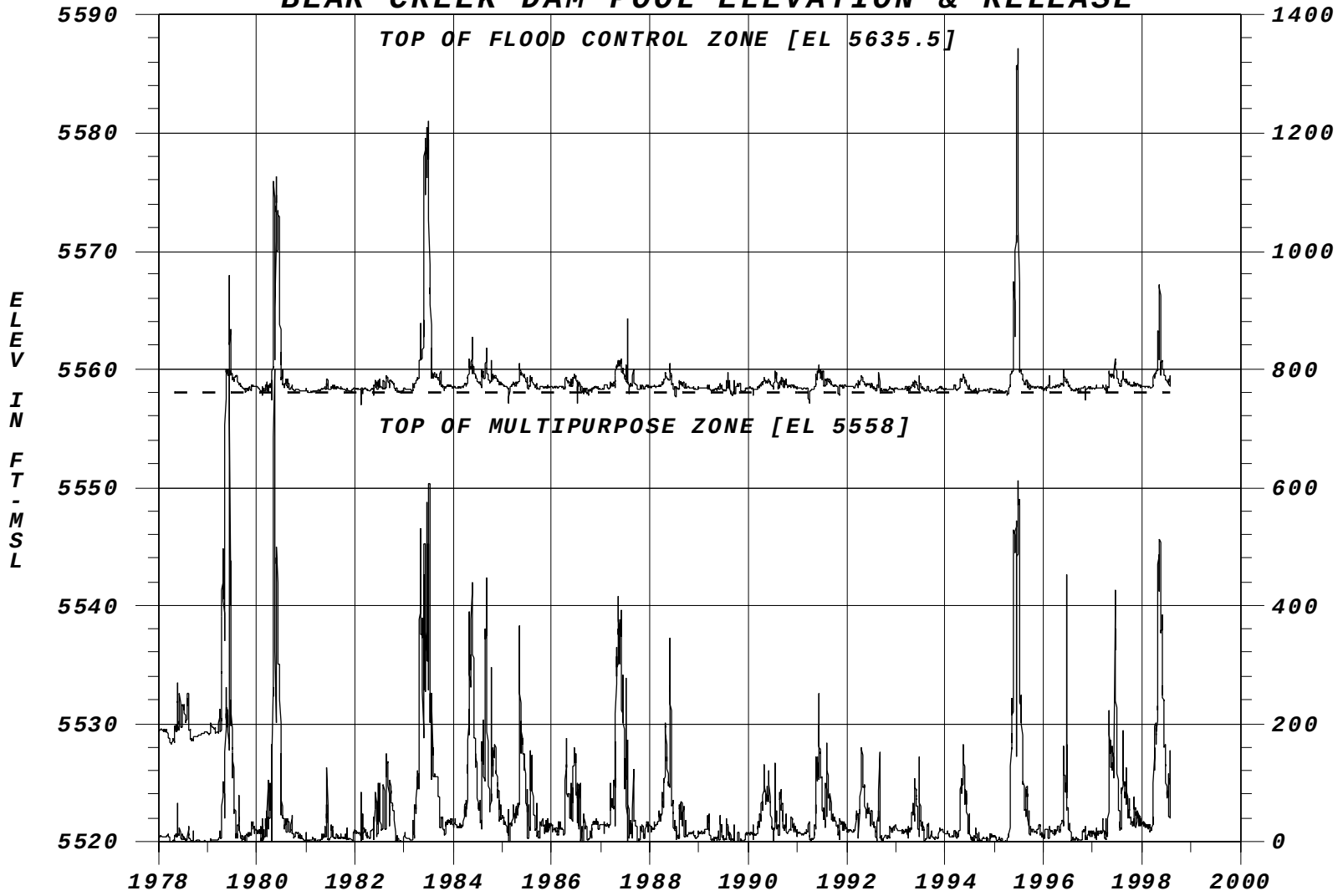


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

BEAR CREEK DAM POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

BOWMAN-HALEY DAM AND LAKE
GRAND RIVER BASIN, NORTH DAKOTA
1997-1998 REGULATION

The pool level at Bowman Haley exceeded the conservation pool for only five days during the report period, from April 6th to April 10th. This was in part a result of an informal agreement between the Corps, the Natural Resource Conservation Service, the North Dakota Game and Fish Department, and the Bowman County Water Management District to maintain a pool level from 1.0 feet to 2.0 feet below the top of conservation pool. Maintaining the pool at this level is being done in an attempt to reduce shoreline erosion, help establish riparian vegetation, and improve water quality by reducing turbidity.

Virtually all water that was released from the project flowed out of the low-level drawdown tube and the mid-level gate. Of the 10,126 acre-feet that was released during the report period, an estimated 10,111 acre-feet flowed out of the low-level and mid-level gates. Water quality should also benefit by releasing poorer quality water from the bottom of the reservoir.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	5,310 cfs Mar 27 78	2,390 cfs Mar 28 78
2nd	2,135 cfs Jun 14 92	1,256 cfs May 15 95
3rd	2,096 cfs May 09 95	1,125 cfs Mar 14 72

	Pool-Date
Highest	2762.66 Mar 28 78
2nd	2758.78 May 14 95
3rd	2758.50 Mar 13 72

Minimums of Record (since initial fill):

	Pool-Date
Lowest	2747.57 Jun 12 92
2nd	2749.17 Jul 31 91
3rd	2749.93 Nov 16 81

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
13,586, 63% of normal

Total Outflow (AF)
10,126, 63% of normal

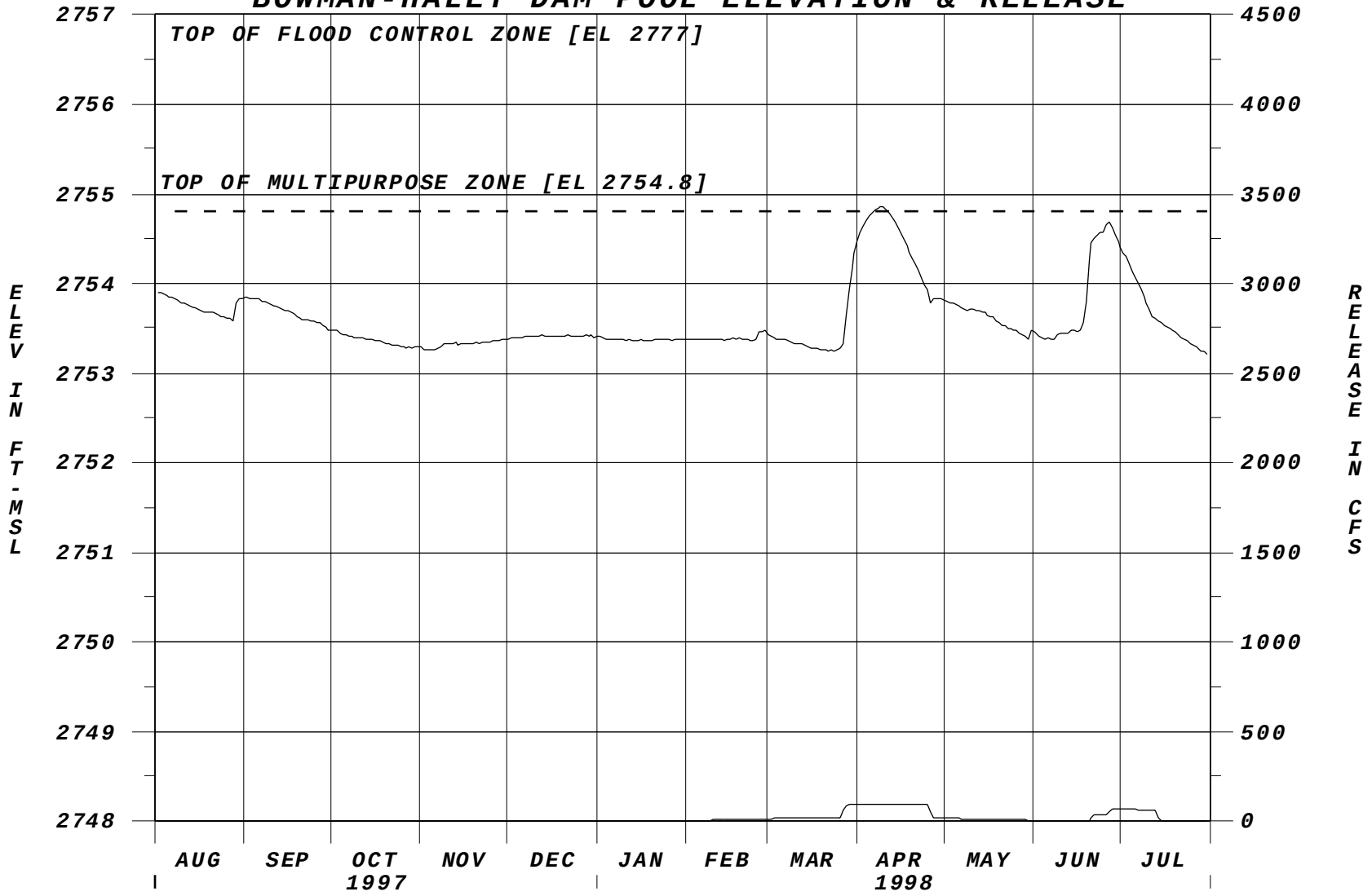
Peak Daily Inflow (CFS)
390, Jun 19

Peak Daily Outflow (CFS)
94, Apr 09

Peak Pool Elevation (FT-MSL)
2754.85, Apr 09

Minimum Pool Elevation (FT-MSL)
2753.18, Jul 31

BOWMAN-HALEY DAM POOL ELEVATION & RELEASE

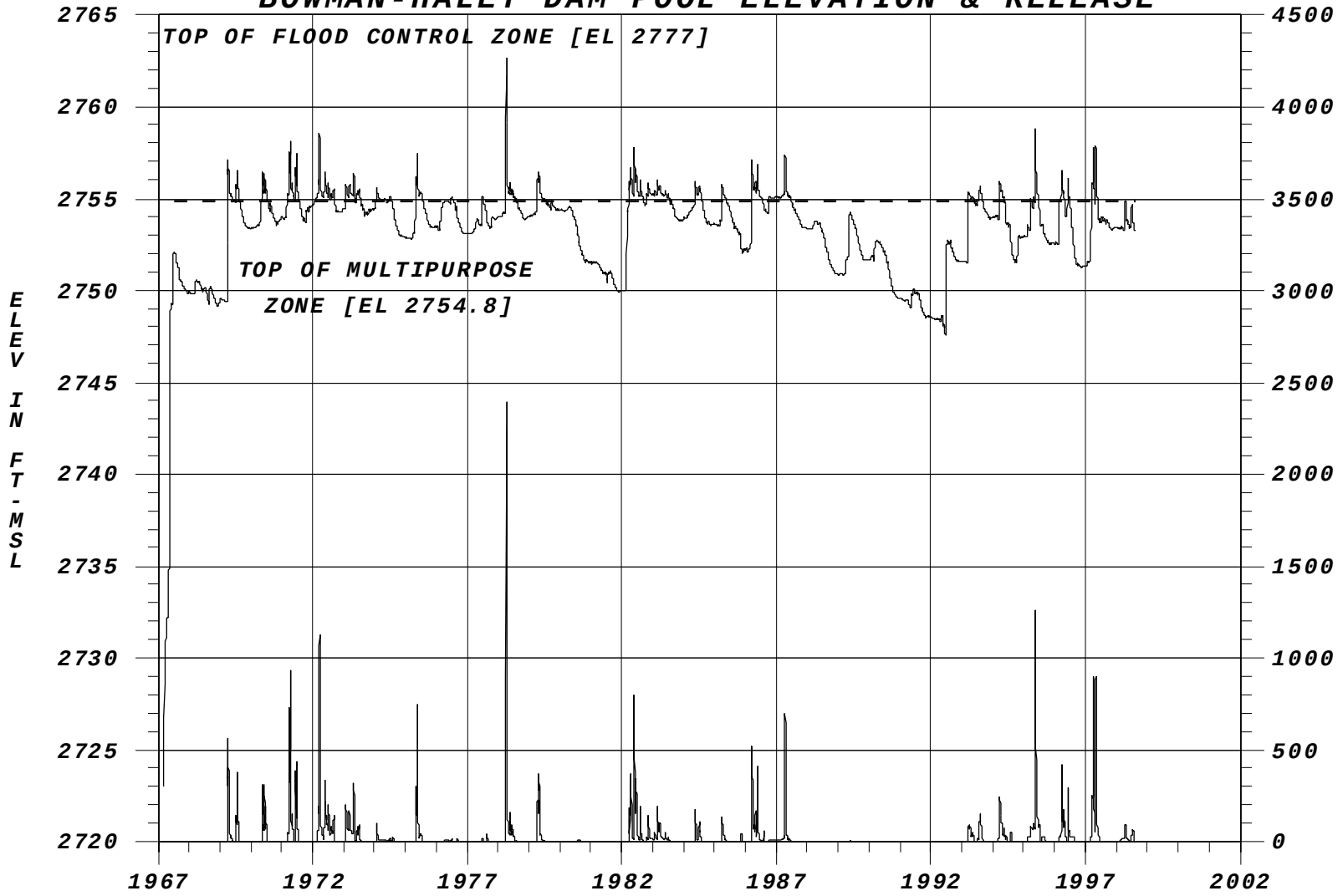


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

BOWMAN-HALEY DAM POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

BULL HOOK-SCOTT COULEE DAMS
MILK RIVER BASIN, MONTANA
1997-1998 REGULATION

Bull Hook and Scott Coulee Dams are both part of the Bull Hook Unit providing flood control for the city of Havre, Montana. Bull Hook and Scott Coulee Dams are both located south of Havre on Bull Hook and Scott Coulee Creeks, respectively.

Under normal circumstances, the conduit valves of both dams will be kept partially open to evacuate accumulated storage as expeditiously as possible to allow the dams to function as flood protection facilities if excess runoff occurs upstream. Valve openings are to be maintained that will allow only the minimal damages to occur in the City of Havre.

At times of high flows on the Milk River, it may be necessary to shut off releases in both dams to prevent flooding behind the Milk River levees.

No reports of heavy inflow into Bull Hook-Scott Coulee Dams were made during the report period.

CEDAR CANYON DAM (RED DALE GULCH)
RAPID CREEK BASIN, SOUTH DAKOTA
1997-1998 REGULATION

Cedar Canyon Dam is located on the western outskirts of Rapid City, South Dakota. The dam is designed as a detention structure with no permanent storage. However, a small pool may sometimes exist in the dead storage below the invert of the outlet pipe. The dam collects runoff from approximately 261 acres. The outlet and spillway are uncontrolled. No water accumulated during the report period. Inflow was negligible and outflow was zero for the period. No flood control was achieved.

CHATFIELD DAM AND LAKE
SOUTH PLATTE RIVER BASIN, COLORADO
1997-1998 REGULATION

Before Chatfield Dam became operational, the Corps Water Control Section requested that the Colorado State Engineers Office, acting through the District 8 Water Commissioner, assume responsibility for determining releases from the multipurpose pool in an effort to keep the Corps free of water rights conflicts. This relationship was put into a formal document dated March 30, 1973, when the multipurpose pool was increased from elevation 5430.0 to 5432.0 ft-msl and contained water storage commitments by the State. By contract, the State is committed to keeping the pool above elevation 5423.0 ft-msl for recreation and fish and wildlife purposes. Since 1979, the City of Denver through the State of Colorado has been permitted to regulate storage in the conservation pool in return for the city's commitment to provide sufficient water in the pool for recreation. The city is committed to keeping 20,000 acre-feet (Elevation 5426.94 ft-msl) of water in the pool from May 1st through August 31st, and permitted to use 10,000 acre-feet of storage space in the reservoir between elevations 5423.8 and 5432.0 ft-msl. The original top of multipurpose pool level was at elevation 5426.0 ft-msl.

Minor flood control operation of Chatfield Reservoir occurred in June and July. The reservoir was also operated for water supply. The total inflow for the reporting period was 176,187 acre-feet (108% of normal).

Flood storage space utilized was 1070 acre-feet of 206,945 acre-feet, less than 1% of the flood storage space at the maximum pool elevation of 5432.56 ft-msl on July 30th.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	3,390 cfs Jul 03 95	3,034 cfs May 15 84
2nd	3,370 cfs May 30 83	3,027 cfs May 27 87
3rd	3,155 cfs May 09 80	2,858 cfs Jul 08 83

	Pool-Date
Highest	5447.58 May 26 80
2nd	5447.08 Jun 30 83
3rd	5446.40 Jul 04 95

Minimums of Record (since initial fill):

	Pool-Date
Lowest	5423.6 Dec 18 95
2nd	5424.33 Nov 21 90

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
176,187, 108% of normal

Total Outflow (AF)
172,181, 109% of normal

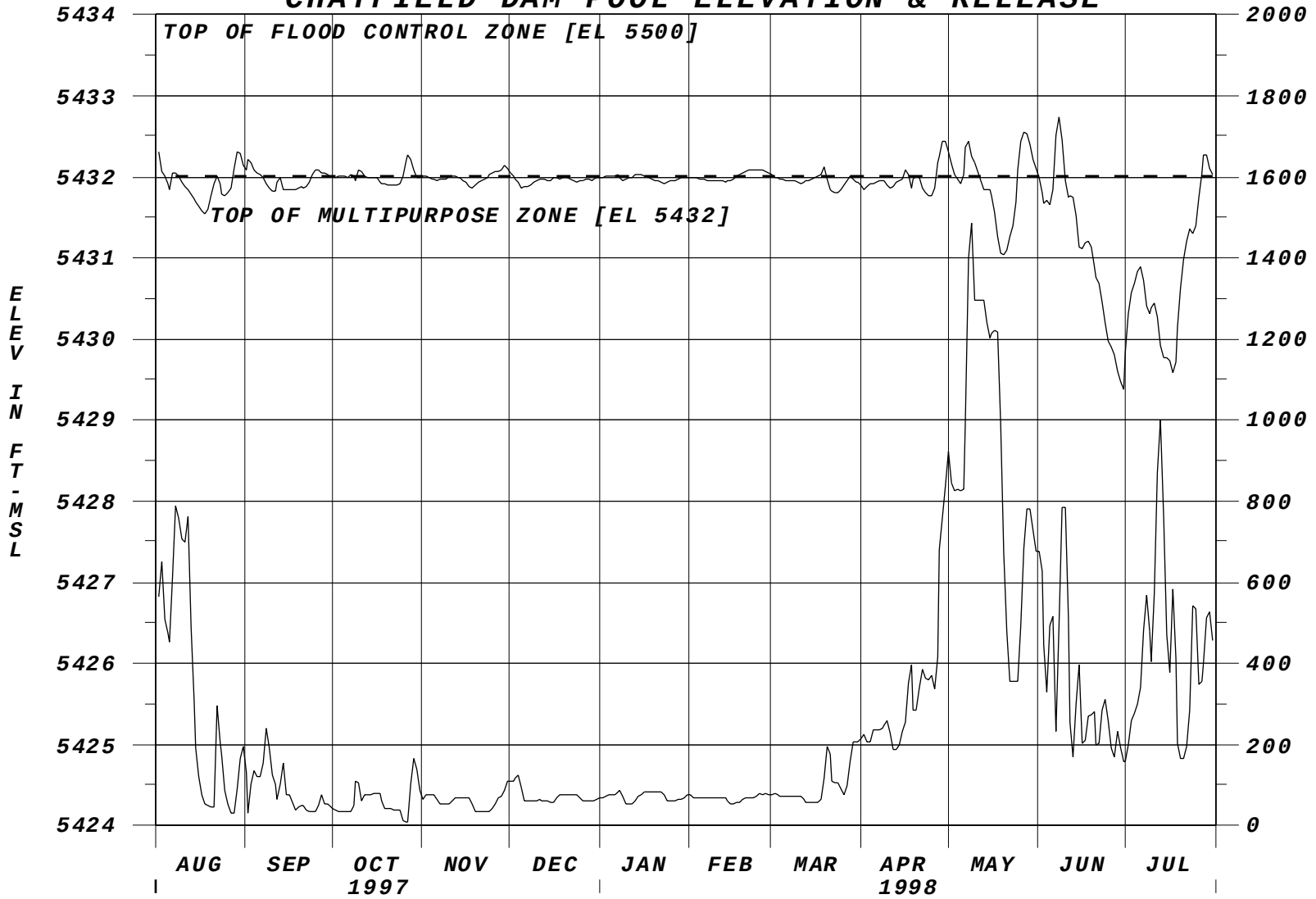
Peak Daily Inflow (CFS)
1467, May 07

Peak Daily Outflow (CFS)
1484, May 08

Peak Pool Elevation (FT-MSL)
5432.74, Jun 07

Minimum Pool Elevation (FT-MSL)
5425.67, Sep 08

CHATFIELD DAM POOL ELEVATION & RELEASE

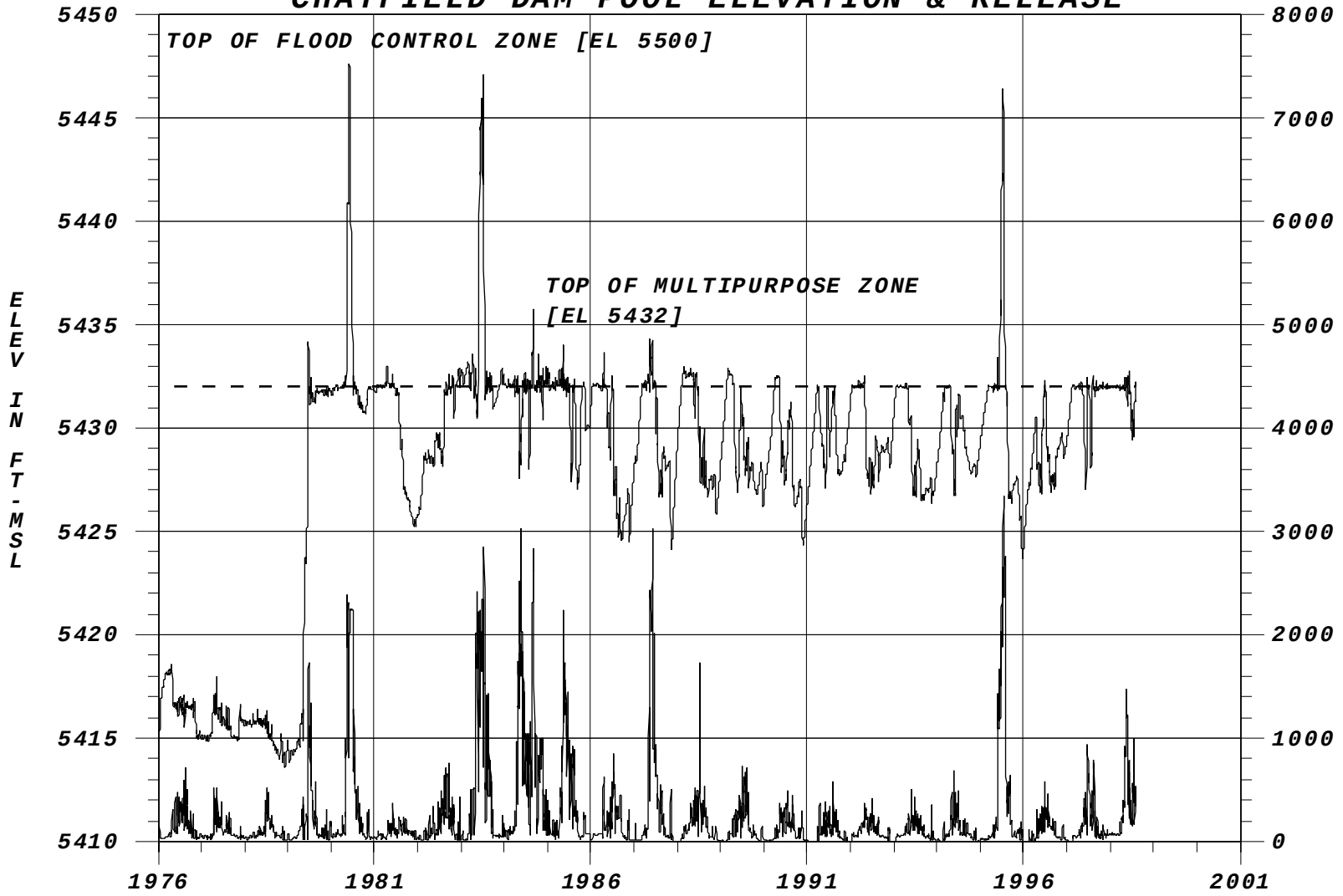


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

CHATFIELD DAM POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

CHERRY CREEK DAM AND LAKE
CHERRY CREEK, SOUTH PLATTE RIVER BASIN, COLORADO
1997-1998 REGULATION

Releases from the project are made to evacuate flood control zone storage and to meet downstream water rights calls. Each year, water is released from four of the five gates to flush accumulated sediment.

The low-level flushing operation to remove sediment from the intake structure was not accomplished this year due to scheduled gate maintenance. The flush will be accomplished next year.

Inflows to Cherry Creek Reservoir for the report period were 21,080 acre-feet, 240% of average. The peak monthly inflow occurred in April, with 3,971 acre-feet entering the reservoir. The peak daily inflow was 394 cfs on July 31st.

A total of 1,045 acre-feet or about 1% of the 79,960 acre-feet exclusive flood storage zone was utilized at the maximum pool elevation of 5551.2 ft-msl on July 31st. Minimal downstream flooding was prevented by this project.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	6,150 cfs Jun 16 65	560 cfs Aug 7-8 65
2nd	3,195 cfs May 06 73	375 cfs Jun 08 75
3rd	1,440 cfs Jul 24 83	330 cfs Apr 23-May 1 83 May 28-Jun 2 83

	Pool-Date
Highest	5565.82 Jun 03 73
2nd	5562.52 Aug 01 65
3rd	5557.89 Jul 25 83

Minimums of Record (since initial fill):

	Pool-Date
Lowest	5543.51 Jan 29 65
2nd	5545.90 Nov 23-24 78

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
21,080, 240% of normal

Total Outflow (AF)
17,240, 296% of normal

Peak Daily Inflow (CFS)
394, Jul 31

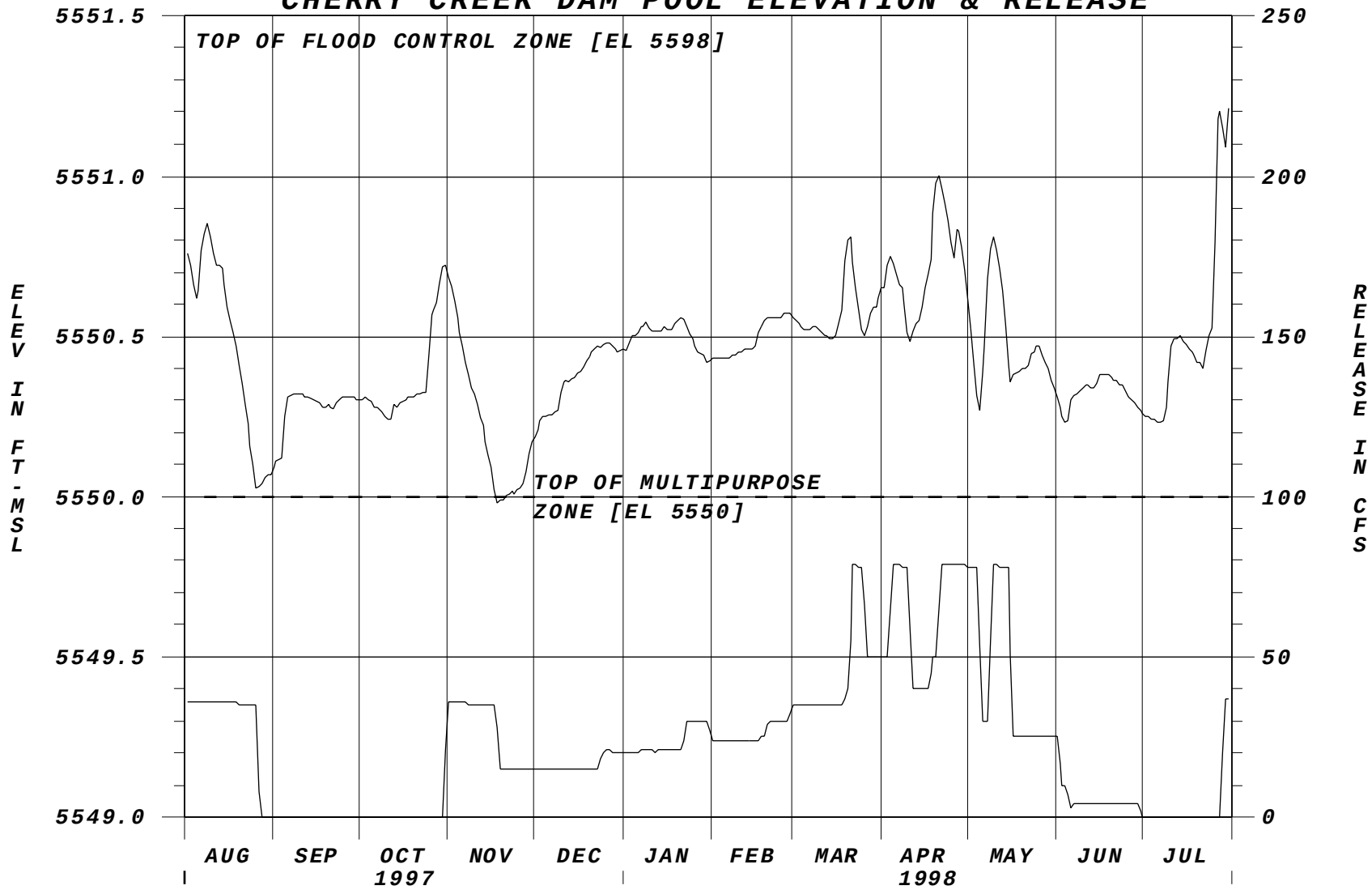
Peak Daily Outflow (CFS)*
80, Aug 11

Peak Pool Elevation (FT-MSL)
5552.16, Aug 05

Minimum Pool Elevation (FT-MSL)
5549.98, Nov 17

* Not including flushing exercise

CHERRY CREEK DAM POOL ELEVATION & RELEASE

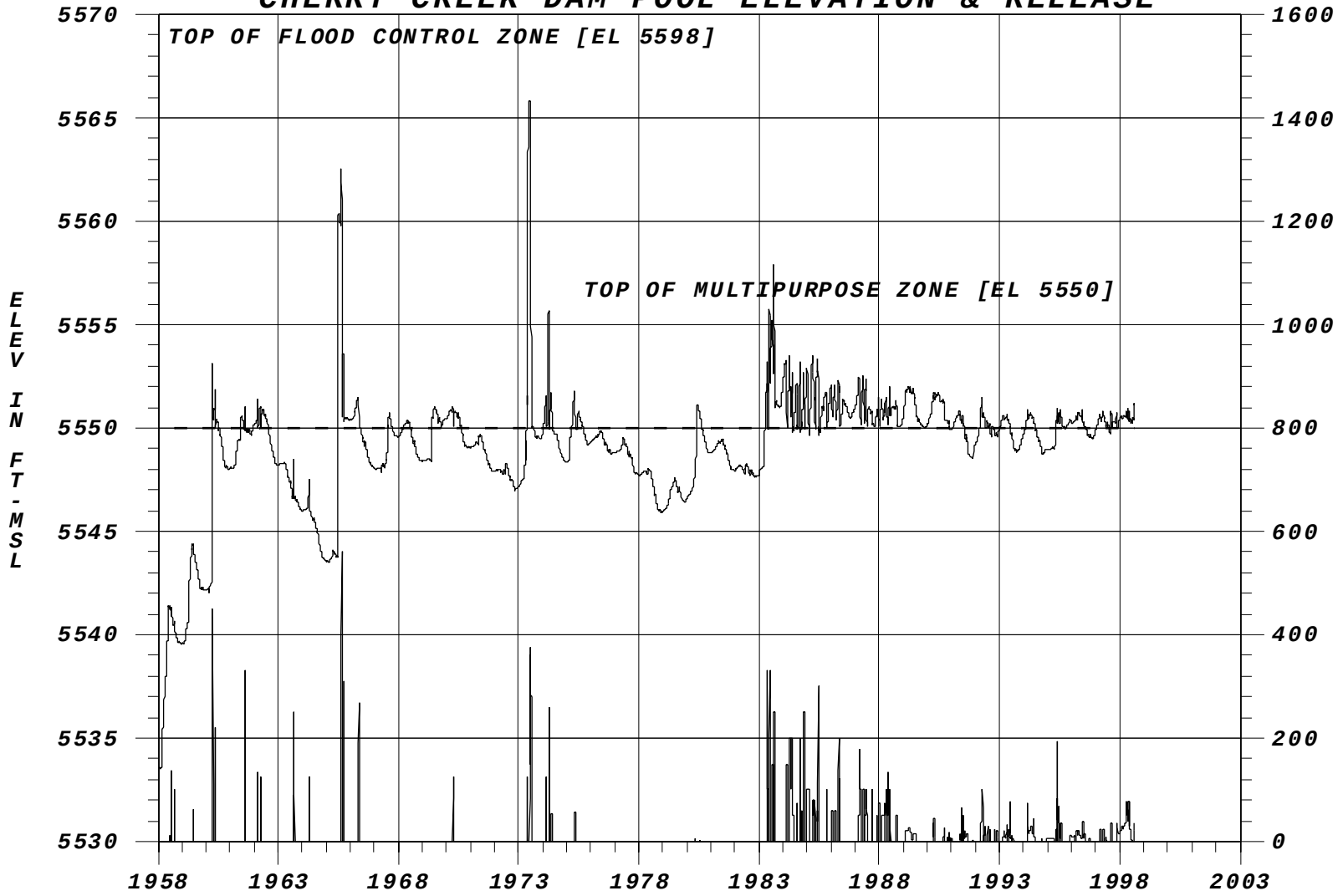


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

CHERRY CREEK DAM POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

COLD BROOK DAM AND LAKE
FALL RIVER BASIN, SOUTH DAKOTA
1997-1998 REGULATION

Releases from Cold Brook Reservoir are regulated to comply with State water law. Larive Lake Resort, located below the dam, holds a senior water right entitling it to the Cold Brook Reservoir inflow up to 1.1 cfs. Water has spilled from the project from November, 1994 to the present.

One noteworthy event should be recorded although it occurred outside the report period. On October 28, 1998, around 12:00 noon, a contractor working on the low level gates that drain the conservation pool inadvertently partially opened either one or more gates and didn't close them until the following day, October 29 around 2:00 pm. The discharge through the gates was estimated to be 10 cfs based on the change in storage and the approximate inflow. The three gates have a capacity of 20 cfs each or a total capacity of 60 cfs. The discharge of 10 cfs represents the most that has ever been released from Cold Brook Reservoir since it was closed in 1952. The release resulted in water flowing through the 24-inch diameter culvert underneath the road to the project office, through the 18-inch culvert under the main road to the spillway, and into the channel several hundred feet to the south of Evans Street. No damage was reported as the water did not reach the neighborhood where the channel is covered up.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	74 cfs Jul 14 62	5 cfs Aug 24-Sep 6 93
2nd	65 cfs Jul 08 61	4 cfs Mar 02 94
3rd	40 cfs May 19 82	3 cfs Jul 16 95

	Pool-Date
Highest	3585.42 Jun 13 98
2nd	3585.41 Jul 16 95
3rd	3585.39 Jul 19 97

Minimums of Record (since initial fill):

	Pool-Date
Lowest	3576.6 Oct 22 77
2nd	3576.8 Sep 14-Oct 02 81 Sep 21-22-77

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
933, 144% of normal

Total Outflow (AF)
815, 149% of normal

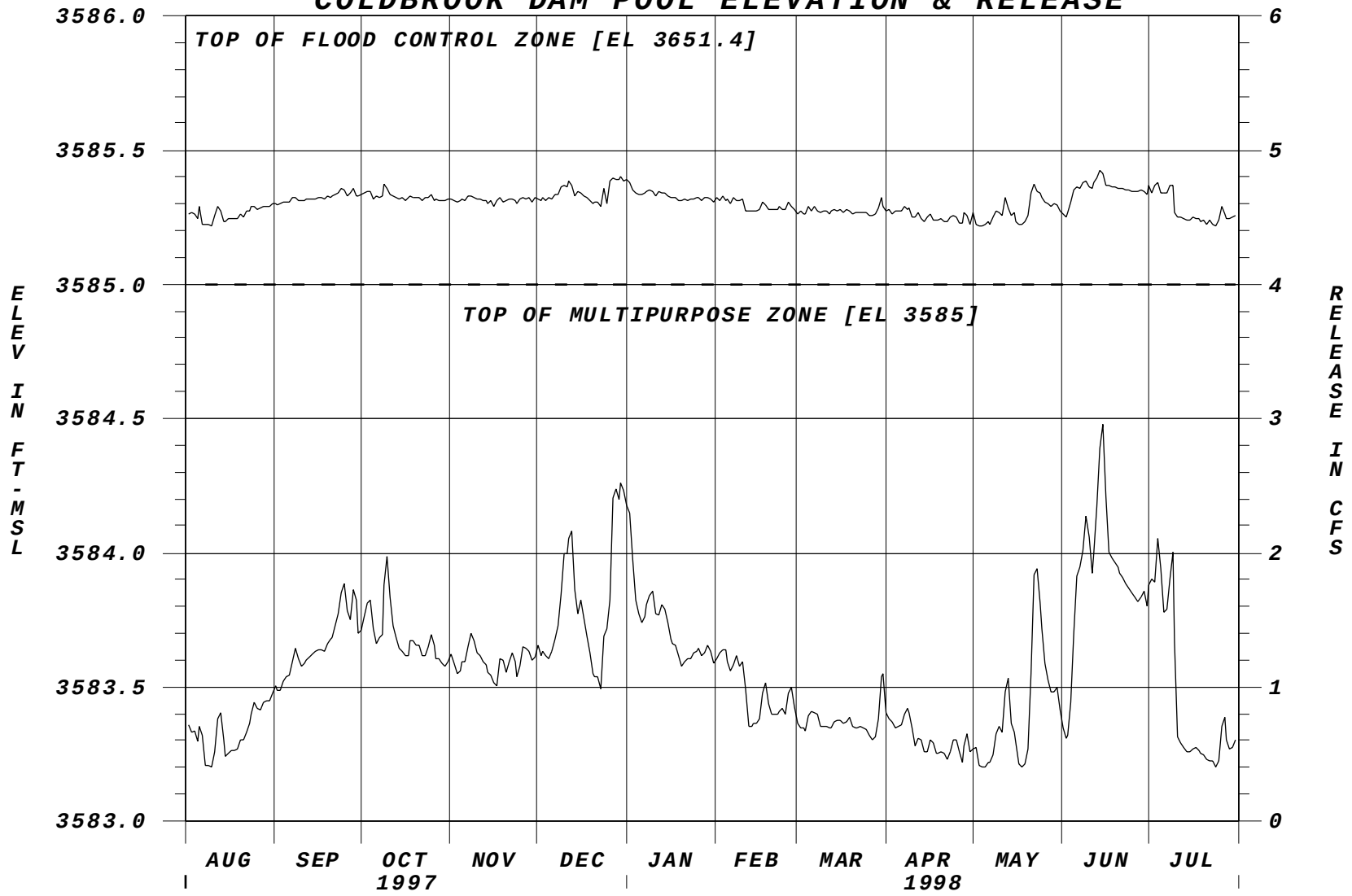
Peak Daily Inflow (CFS)
4.0, Jun 13

Peak Daily Outflow (CFS)
3.0, Jun 14

Peak Pool Elevation (FT-MSL)
3585.42, Jun 13

Minimum Pool Elevation (FT-MSL)
3585.22, May 02

COLDBROOK DAM POOL ELEVATION & RELEASE

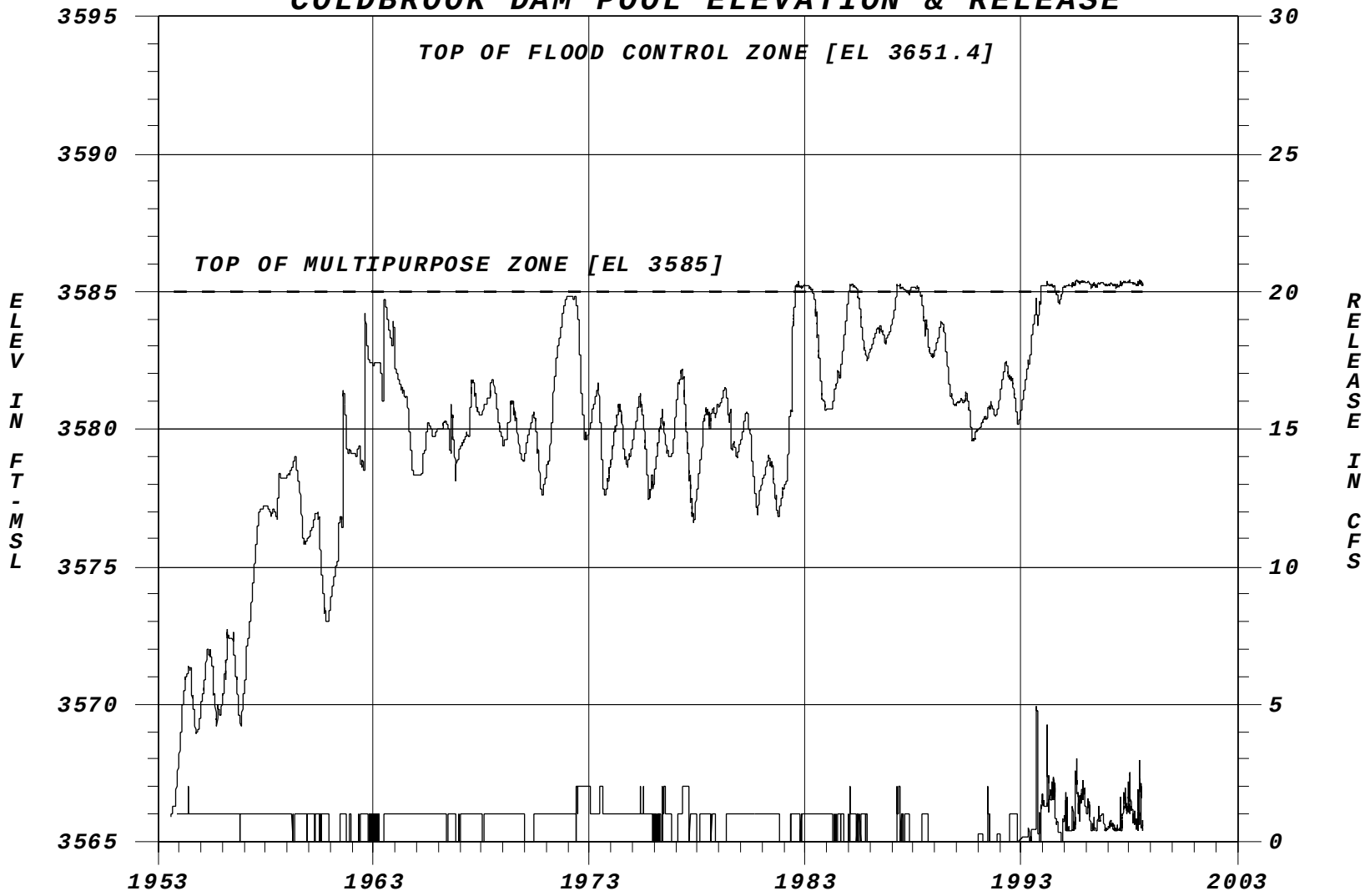


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

COLDBROOK DAM POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

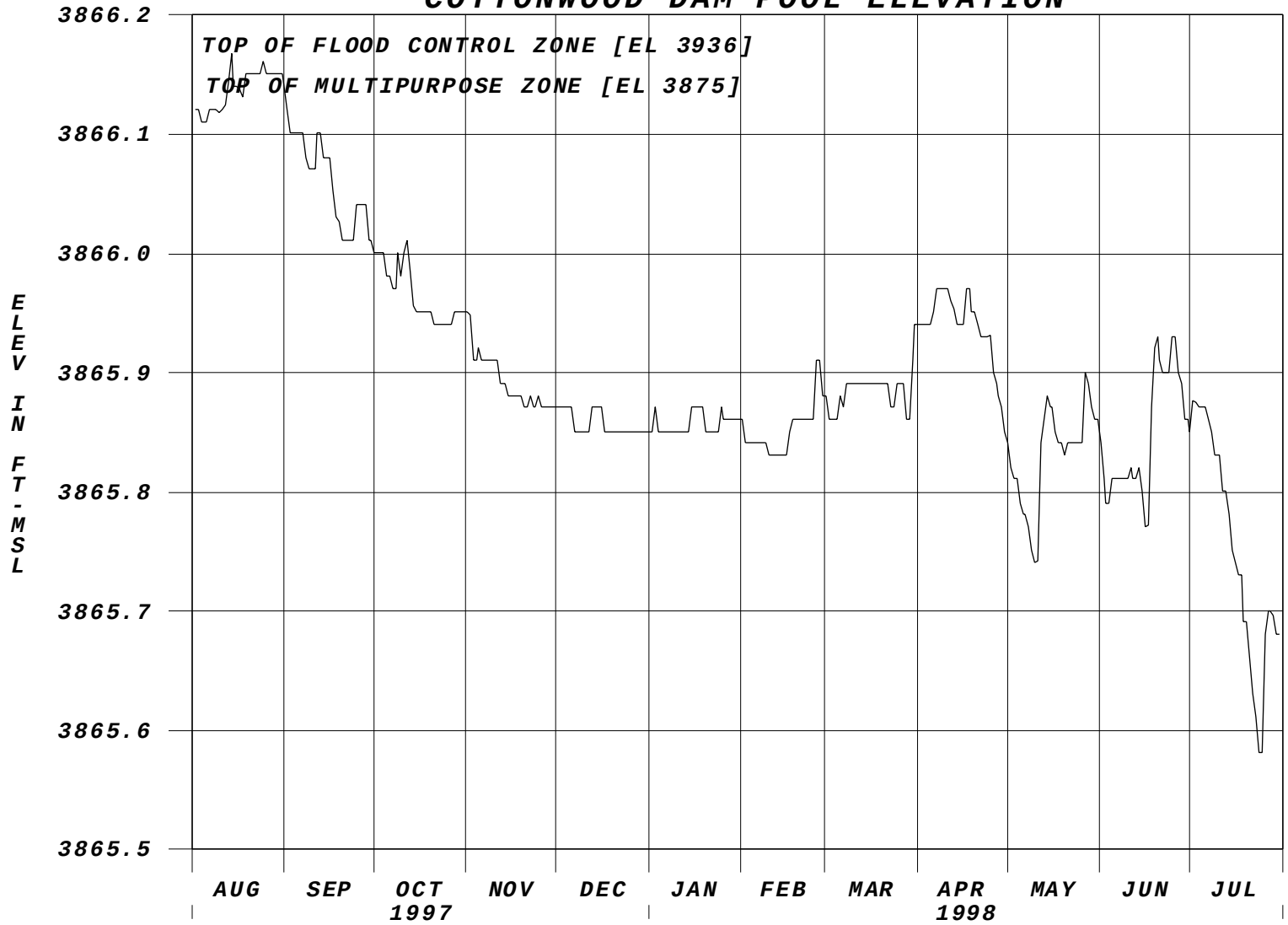
COTTONWOOD SPRINGS DAM AND LAKE
FALL RIVER BASIN, SOUTH DAKOTA
1997-1998 REGULATION

Cottonwood Springs Dam is located on Cottonwood Springs Creek approximately 1/2 mile above its confluence with Hot Brook, a tributary of Fall River. The site is located 4.5 miles west of Hot Springs, Fall River County, South Dakota. The purpose for the project is to provide flood protection for Hot Springs, South Dakota and along the Fall River.

Maximums of Record:

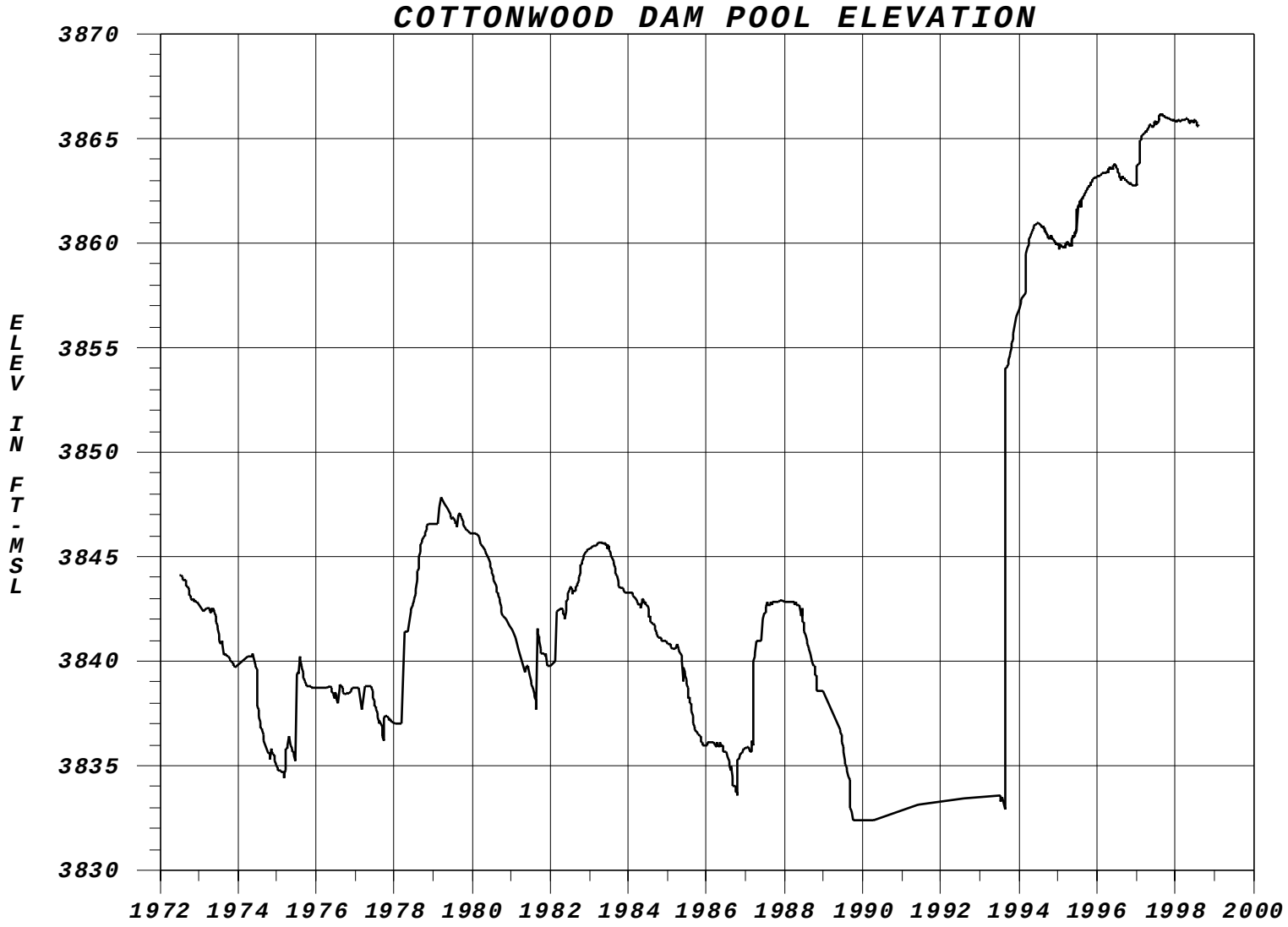
	Pool Date
Highest	3866.17 Aug 13 97
2nd	3863.78 May 30 96
3rd	3861.00 Jun 11-25 94

COTTONWOOD DAM POOL ELEVATION



Prepared By:_____

Reviewed By:_____



F TOP OF MUD DAM ZONE [EL 3936]

KELLY ROAD DAM
SAND CREEK BASIN, COLORADO
1997-1998 REGULATION

Kelly Road Detention Dam is located on Westerly Creek, a tributary of Sand Creek and the South Platte River and provides flood control for the City of Aurora, Colorado. It is located entirely within the boundaries of the closed Lowry Air Force Base. The project's sole purpose is flood control and was not designed to permanently store water. Water is automatically impounded by the project and released through a ground level 24-inch CMP conduit or high overflow inlet. A gate on the 24-inch conduit is kept in the open position. The intended closure of the gate is to contain oil or other spills within the air base. The City of Aurora is responsible for obtaining pool gage readings during flood periods and general observation of project operation.

Kelly Road Dam pool levels fluctuated between 5342.9 and 5349.2 ft-msl during the report period. Inflows remained within the range of 14 to 29 cfs and rainfall for the period was 11.77 inches.

WESTERLY CREEK DAM
SAND CREEK BASIN, COLORADO
1997-1998 REGULATION

The Westerly Creek Dam is located approximately 0.8 miles upstream from the Kelly Road Dam on the southern edge of the former Lowry Air Force Base. Construction of Westerly Creek Dam was completed in July 1991. Both the dam and the detention area are located within the confines of the now closed Lowry Air Force Base and were constructed for the purpose of flood control. The reservoir is generally dry and no permanent storage is provided. The reservoir is discharged by an orifice-controlled outlet structure and overflow spillway. The capacity of the outlet works is 98 cfs at a pool capacity elevation of 5,431.4 ft-msl. Discharge from the outlet works is governed by the capacity of the existing 48-inch RCP storm sewer running into the Kelly Road pool. The sluice gate is intended to remain open unless overtopping of the Kelly Road Dam is imminent or the downstream storm sewer capacity is exceeded due to inflows from the downstream drainage area at this time the gate would be closed until downstream conditions permit releases from the Westerly Creek pool.

No reports of heavy inflow into Westerly Creek Dam were made during the reporting period.

GLENN CUNNINGHAM DAM AND LAKE
PAPILLION CREEK BASIN - NO. 11, NEBRASKA
1997-1998 REGULATION

The pool level stayed in the flood control zone from August 1st to October 31st, it re-entered during November where it remained until July 1st.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	391 cfs Jul 05 98	152 cfs Jun 18 84
2nd	362 cfs Jun 22 94	116 cfs Jun 16 80
3rd	345 cfs Jun 15 80	114 cfs Jun 15 98

	Pool-Date
Highest	1124.4 Jun 17 84
2nd	1123.7 Jun 15 80
3rd	1123.3 Jun 23 94

Minimums of Record (since initial fill):

	Pool-Date
Lowest	1119.0 Jul 19 97 *
2nd	1119.5 Nov 15 89
3rd	1120.2 Oct 30 90

*Due to two feet pool draw down for fish habitat work.

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
12,110, 161% of normal

Total Outflow (AF)
10,029, 164% of normal

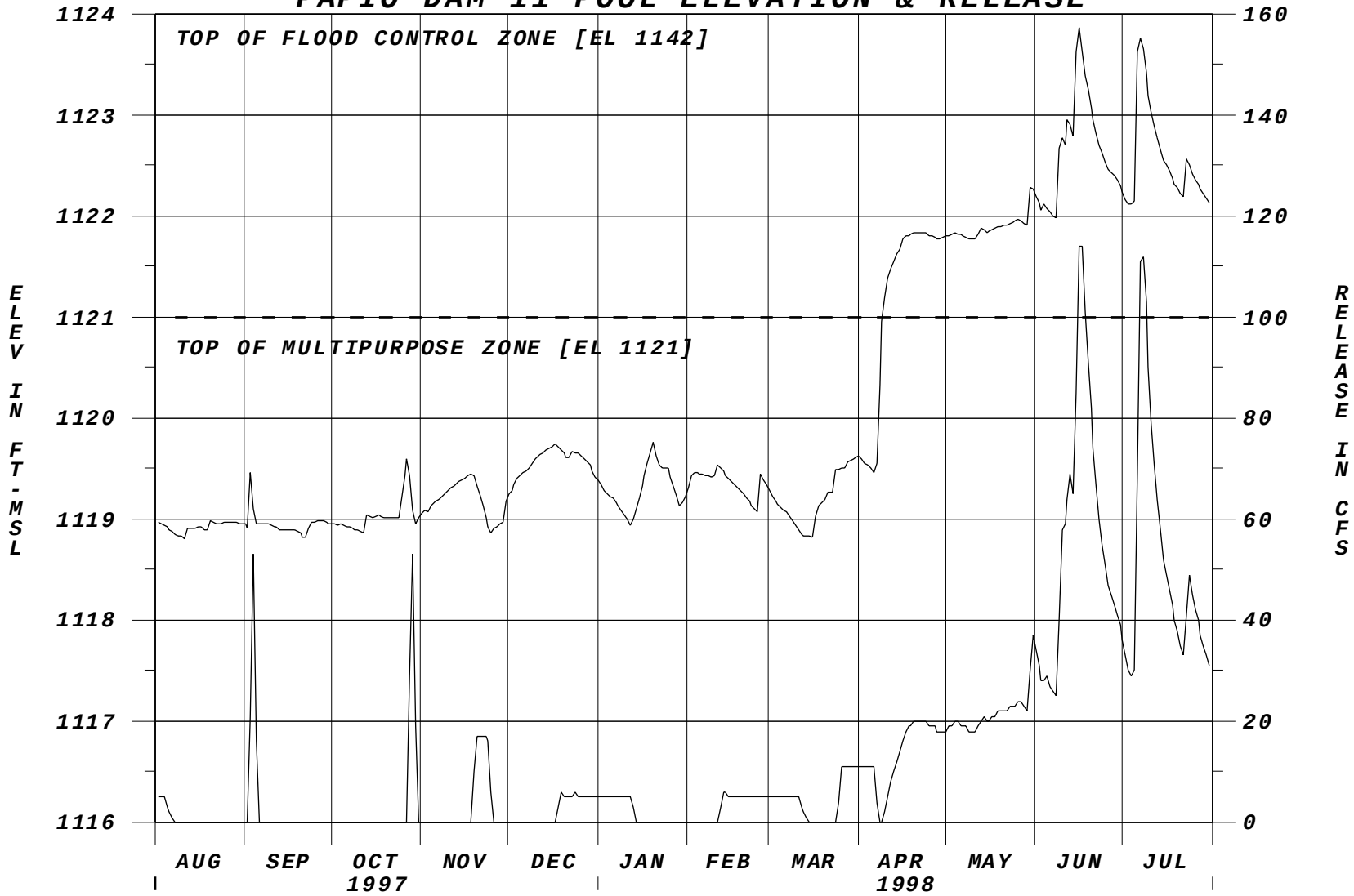
Peak Daily Inflow (CFS)
391, Jul 05

Peak Daily Outflow (CFS)
114, Jun 15

Peak Pool Elevation (FT-MSL)
1123.87, Jun 15

Minimum Pool Elevation (FT-MSL)
1118.81, Aug 10

PAPIO DAM 11 POOL ELEVATION & RELEASE

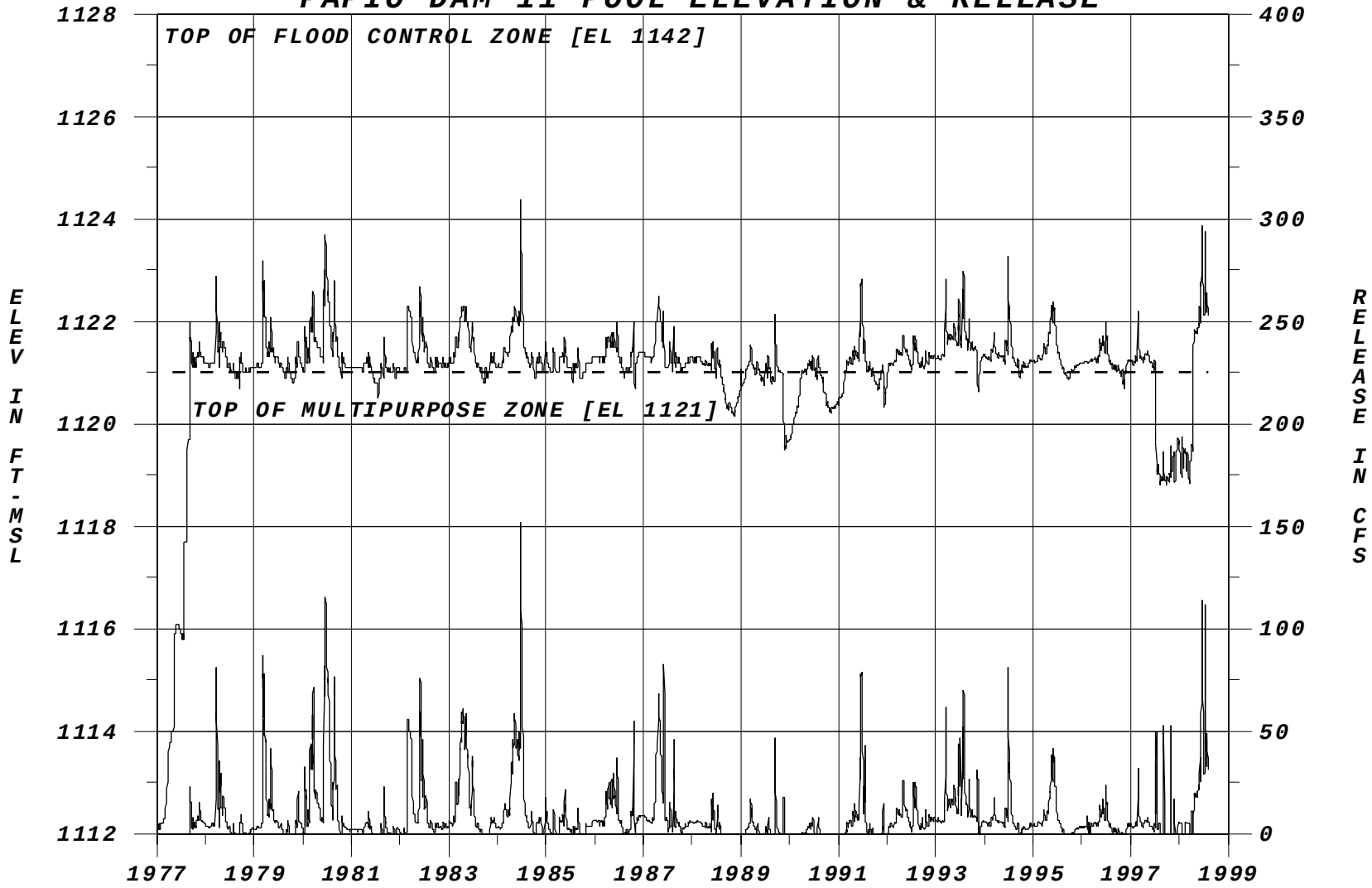


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

PAPIO DAM 11 POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

STANDING BEAR DAM AND LAKE
PAPILLION CREEK BASIN - NO. 16, NEBRASKA
1997-1998 REGULATION

The pool level started the report period below the flood control zone. In September it entered the flood control zone for the first time and fluctuated in and out of the flood control zone until February. Beginning in February the pool remained in the flood control zone for the remainder of the report period, with its peak of 1107.68 ft-msl on July 6th.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	266 cfs Jun 14 84	62 cfs Jun 16-17 84
2nd	235 cfs Aug 09 87	57 cfs Aug 09 87
3rd	211 cfs Jun 22 94	52 cfs May 22 82

	Pool-Date
Highest	1107.8 Jan 16 84
2nd	1107.7 Jul 06 98
3rd	1107.5 Jun 23 94

Minimums of Record (since initial fill):

	Pool-Date
Lowest	1095.9 Feb 28 91
2nd	1097.6 May 22 90

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
3,215, 271% of normal

Total Outflow (AF)
2,749, 401% of normal

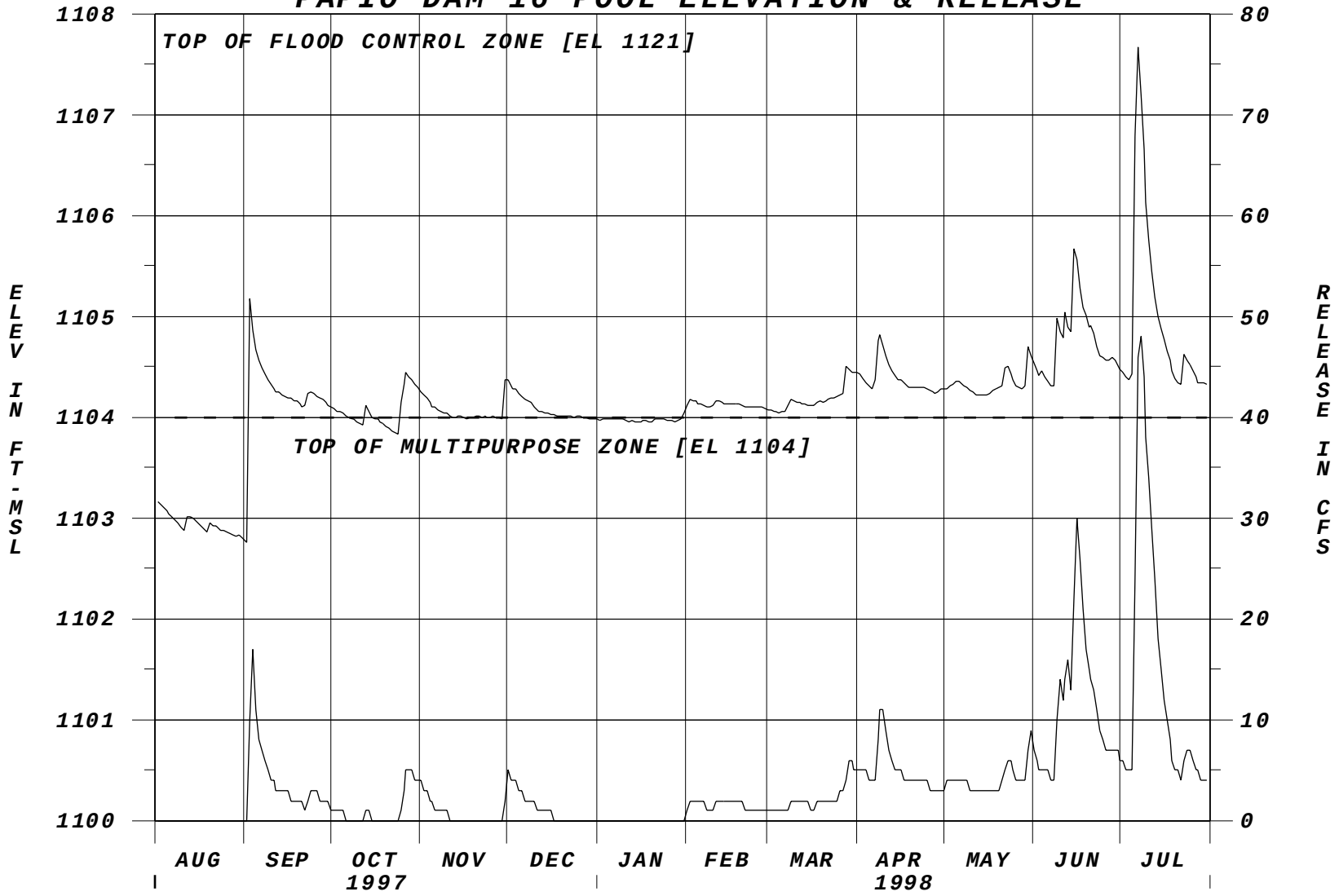
Peak Daily Inflow (CFS)
191, Jul 05

Peak Daily Outflow (CFS)
48, Jul 07

Peak Pool Elevation (FT-MSL)
1107.68, Jul 06

Minimum Pool Elevation (FT-MSL)
1102.77, Sep 01

PAPIO DAM 16 POOL ELEVATION & RELEASE

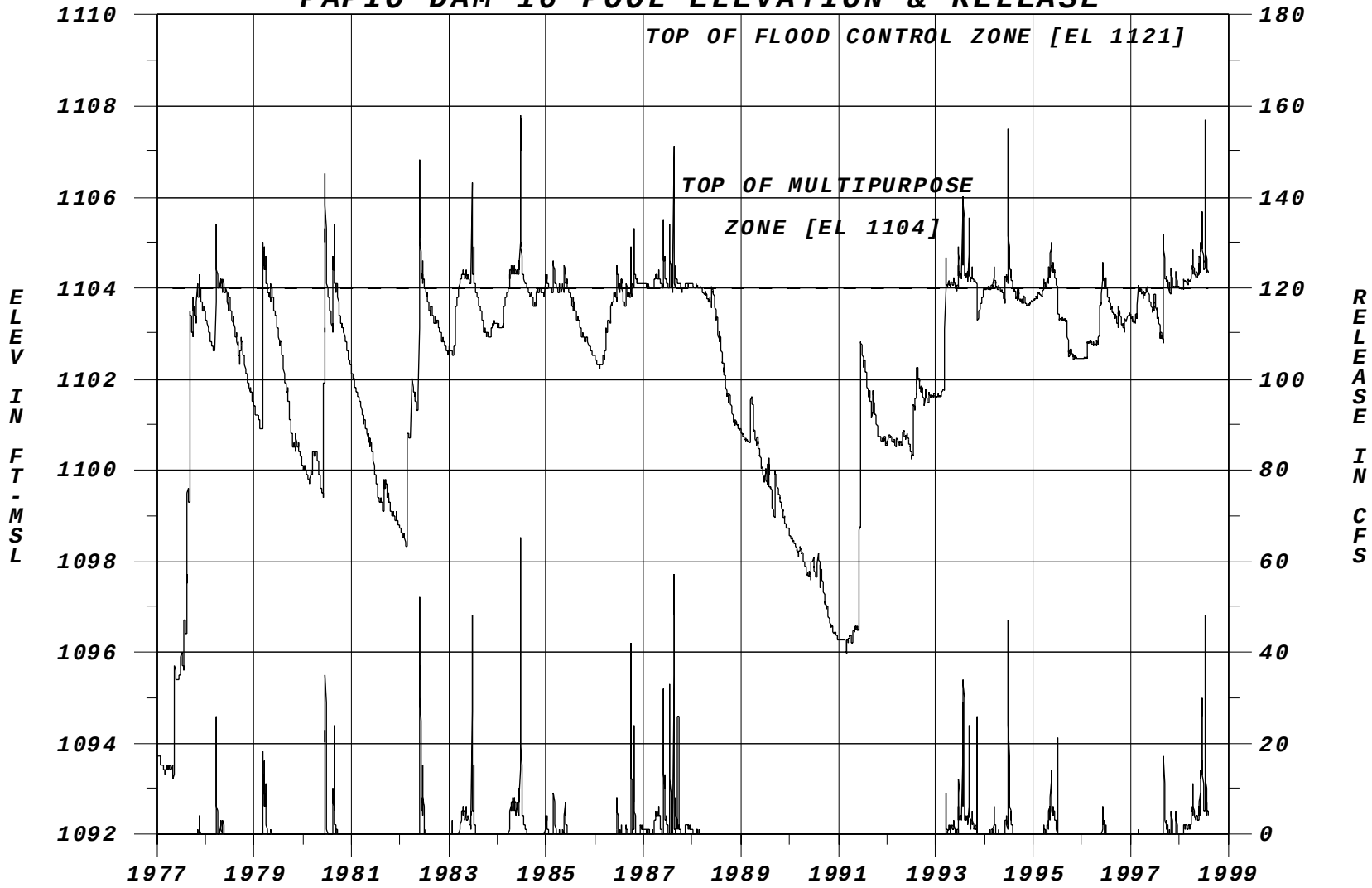


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

PAPIO DAM 16 POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

ZORINSKY DAM AND LAKE
PAPILLION CREEK BASIN - NO. 18, NEBRASKA
1997-1998 REGULATION

The pool level fluctuated above the flood control zone through most of the report period.

In July 1996, the Nebraska Game and Parks Commission requested that the Corps of Engineers draw the lake level down 2.5 feet to facilitate fish habitat enhancement. In late summer or early fall, millet and other types of vegetation is planted on the exposed shoreline. The reservoir level is maintained 2.5 feet below normal levels until spring. At that time, the gates are closed and the lake is allowed to fill to normal level, thus flooding the vegetation and producing fish spawning habitat.

This type of management has continued through 1997 and 1998. Feedback from the Nebraska Game and Parks Commission has been that this type of management has been somewhat successful. Reservoir level timing is critical and the practice seems to work better at some reservoirs than others. This operation will be continued through the spring of 1999 and the results evaluated.

A total of 833 acre-feet or about 11% of the 7649 acre-feet flood pool was utilized at the maximum pool of 1112.96 ft-msl during the report period.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	561 cfs Jun 14 91	142 cfs Jul 25 93
2nd	530 cfs Jul 24 93	113 cfs Aug 31 93
3rd	423 cfs Aug 30 93	102 cfs Sep 01 93

	Pool-Date
Highest	1116.79 Jul 24 93
2nd	1114.75 Aug 30 93
3rd	1111.31 Jul 12 92

Minimums of Record (since initial fill):

	Pool-Date
Lowest	1106.50 Aug 13 96
2nd	1108.53 Nov 09 91

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
8,080, 183% of normal

Total Outflow (AF)
8,037, 213% of normal

Peak Daily Inflow (CFS)
419, Aug 21

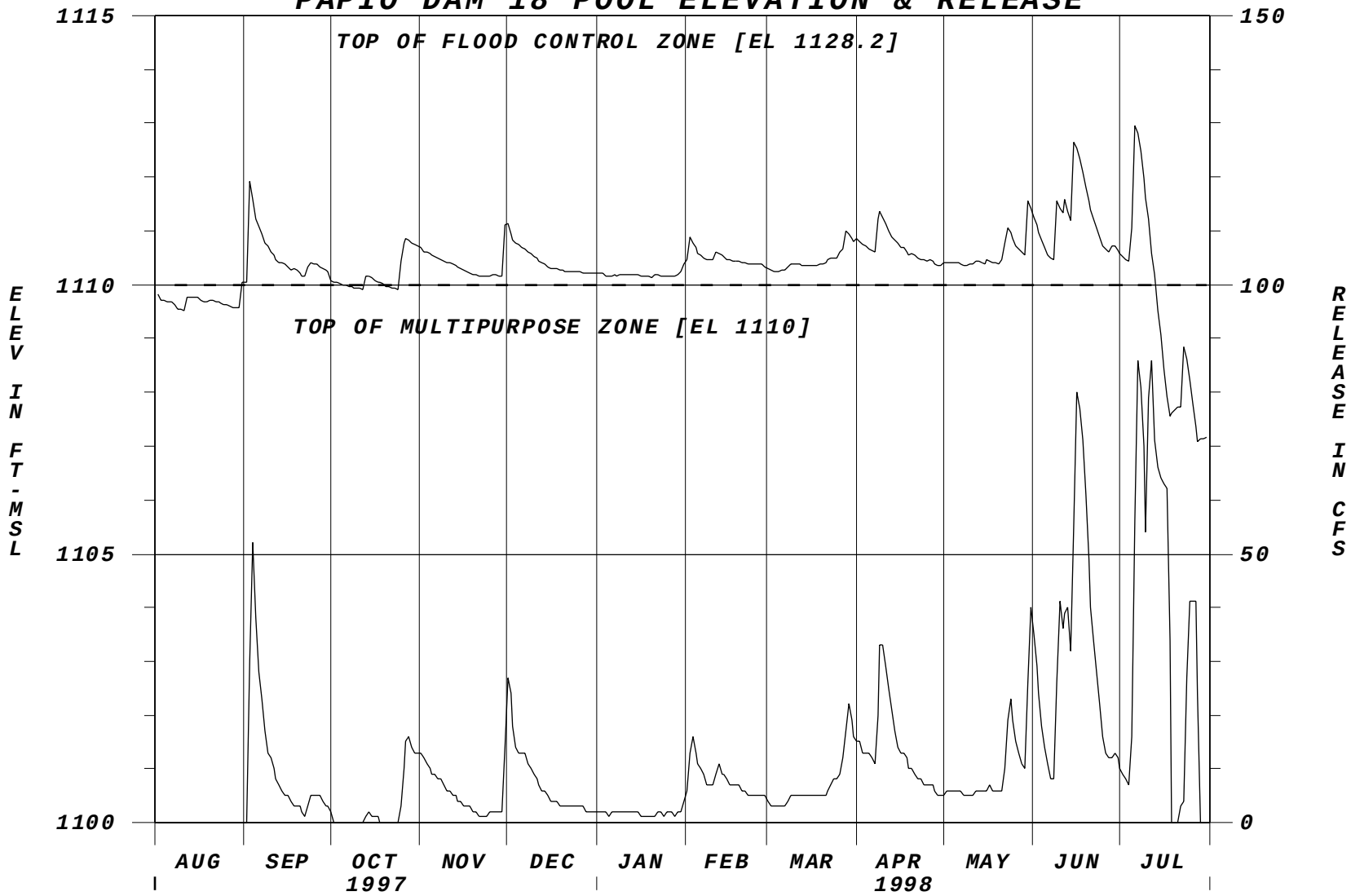
Peak Daily Outflow (CFS)
86, Jul 06

Peak Pool Elevation (FT-MSL)
1112.96, Jul 5

Minimum Pool Elevation (FT-MSL)
1107.07, Jul 27*

* Pool lowered 2.5 feet to facilitate fish habitat plantings.

PAPIO DAM 18 POOL ELEVATION & RELEASE

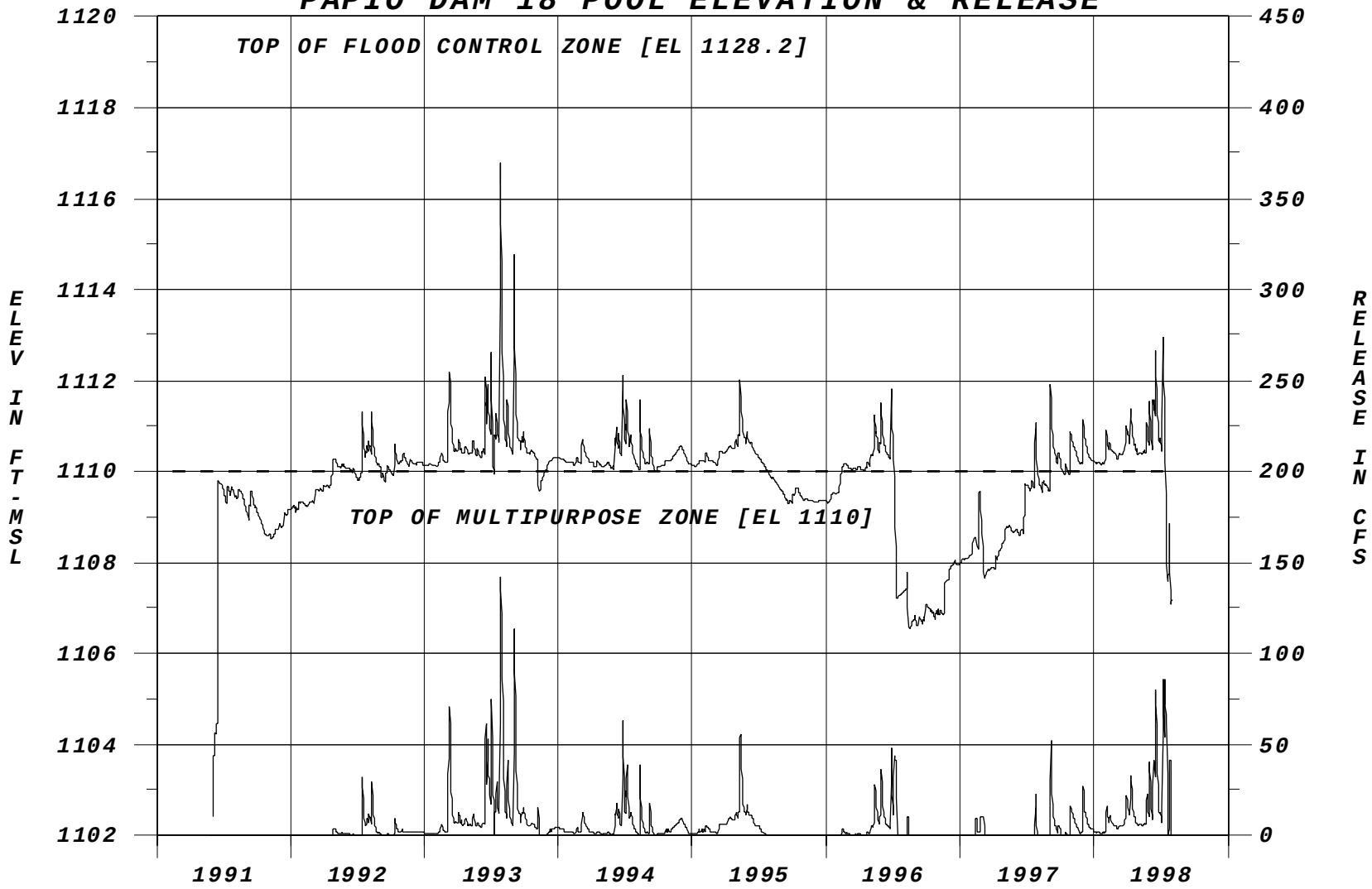


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

PAPIO DAM 18 POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

WEHRSPAN DAM AND LAKE
PAPILLION CREEK BASIN - NO. 20, NEBRASKA
1997-1998 REGULATION

The pool level briefly entered the flood control zone in September. It again entered the flood control zone in late October where it remained for the rest of the report period with the exception of the last week of June and the first week of July. Peak pool level for the report period was 1089.09 ft-msl on June 14th.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	515 cfs Aug 25 87	124 cfs Jul 25 93
2nd	485 cfs Jul 22 93	101 cfs Aug 31 93
3rd	458 cfs Aug 29 93	77 cfs Aug 26 87

	Pool-Date
Highest	1103.20 Jul 24 93
2nd	1101.14 Aug 30 93
3rd	1099.5 Aug 25 87

Minimums of Record (since initial fill):

	Pool-Date
Lowest	1085.4 May 02 90
2nd	1085.9 Feb 02 91

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
4,245, 185% of normal

Total Outflow (AF)
3,239, 249% of normal

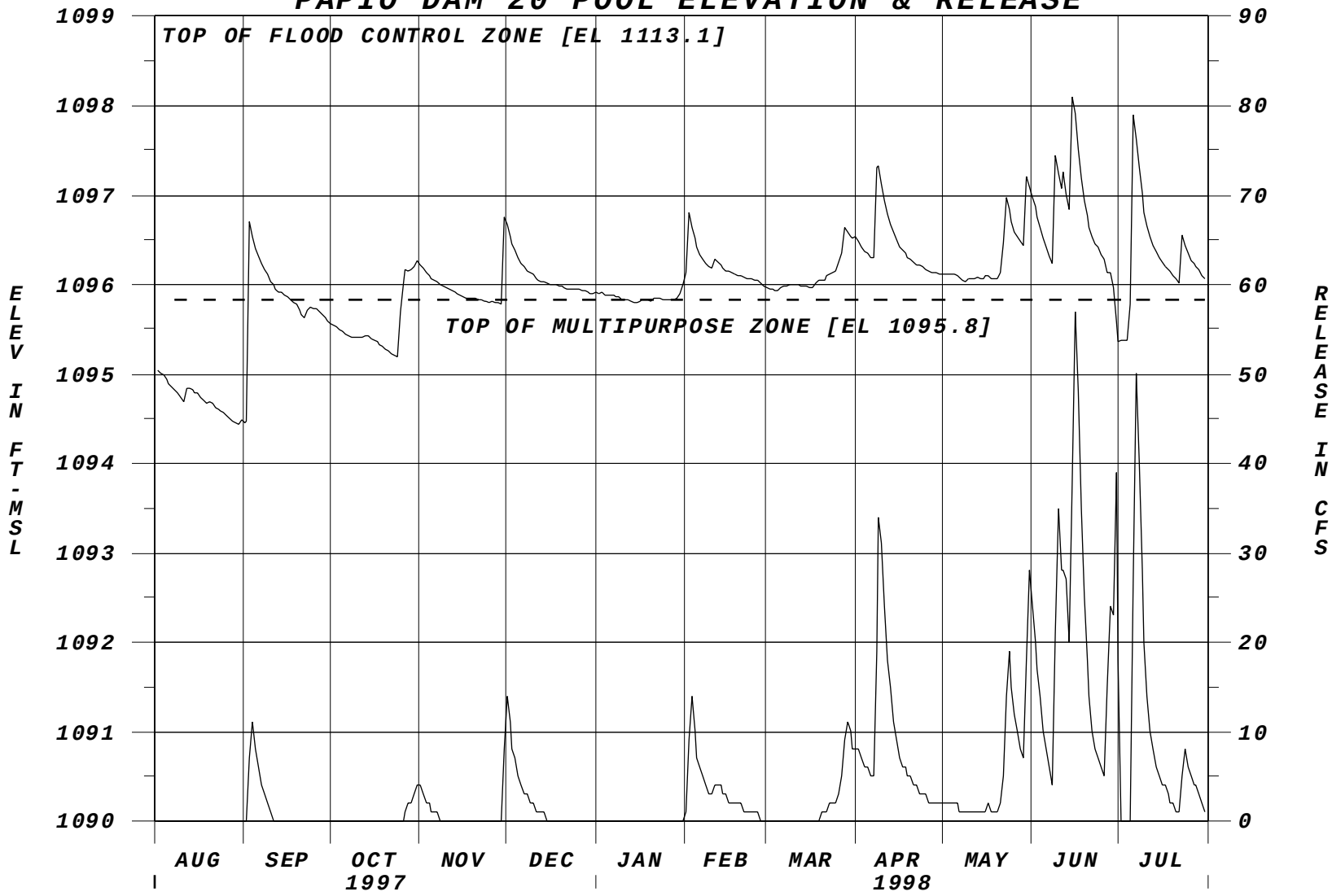
Peak Daily Inflow (CFS)
267, Jul 05

Peak Daily Outflow (CFS)
57, Jun 15

Peak Pool Elevation (FT-MSL)
1089.09, Jun 14

Minimum Pool Elevation (FT-MSL)
1094.43, Aug 29

PAPIO DAM 20 POOL ELEVATION & RELEASE

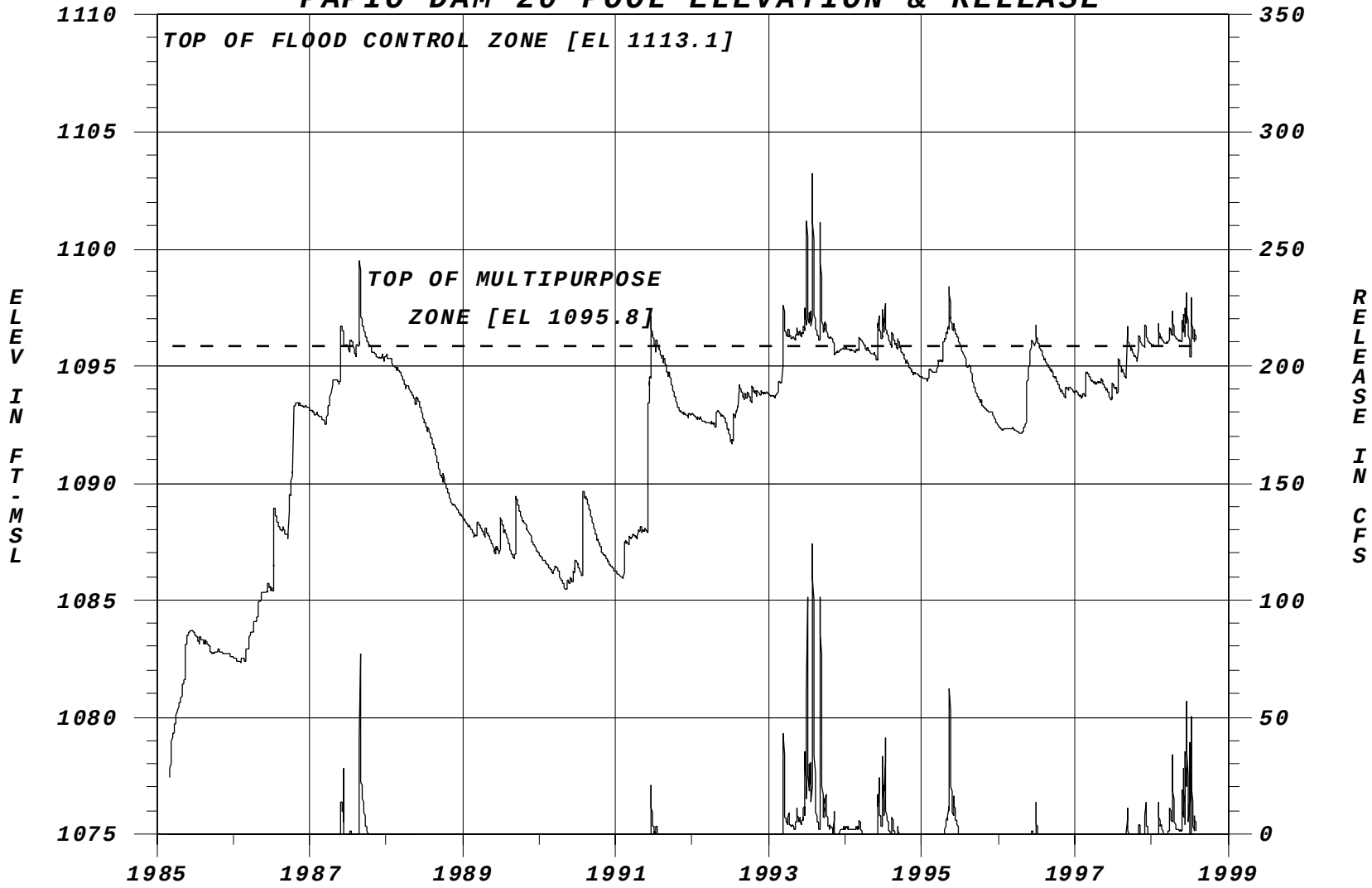


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

PAPIO DAM 20 POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

PIPESTEM DAM AND LAKE
PIPESTEM CREEK, JAMES RIVER BASIN, NORTH DAKOTA
1997-1998 REGULATION

This year was the lowest runoff year since 1993 but was still above average. See the write-up on Pipestem in Section VI for details of this year's operation.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	4,374 cfs Jul 15 93	769 cfs May 23 97
2nd	3,380 cfs Apr 20 75	616 cfs Jun 16 95
3rd	3,231 cfs Apr 1 96	610 cfs Jun 11 96

	Pool-Date
Highest	1487.01 May 10 97
2nd	1479.54 May 22 95
3rd	1475.87 May 08 96

Minimums of Record (since initial fill):

	Pool-Date
Lowest	1439.65 Feb 18 93
2nd	1439.97 Jan 01 77
3rd	1440.60 Jan 27 92

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
67,721, 165% of normal

Total Outflow (AF)
86,302, 230% of normal

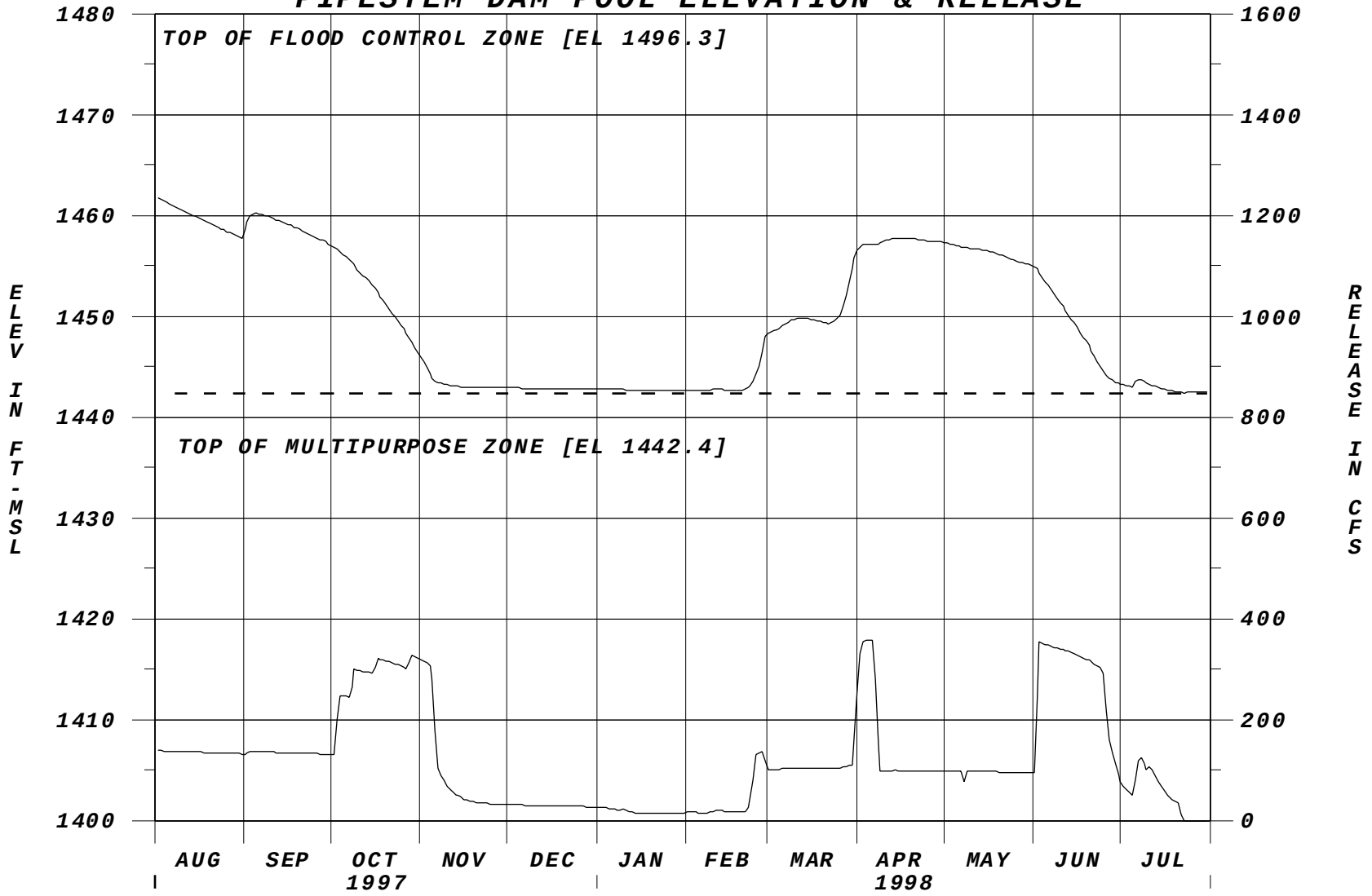
Peak Daily Inflow (CFS)
1,134, Mar 29

Peak Daily Outflow (CFS)
357, Apr 03

Peak Pool Elevation (FT-MSL)
1461.76, Aug 01

Minimum Pool Elevation (FT-MSL)
1442.46, Jul 31

PIPESTEM DAM POOL ELEVATION & RELEASE

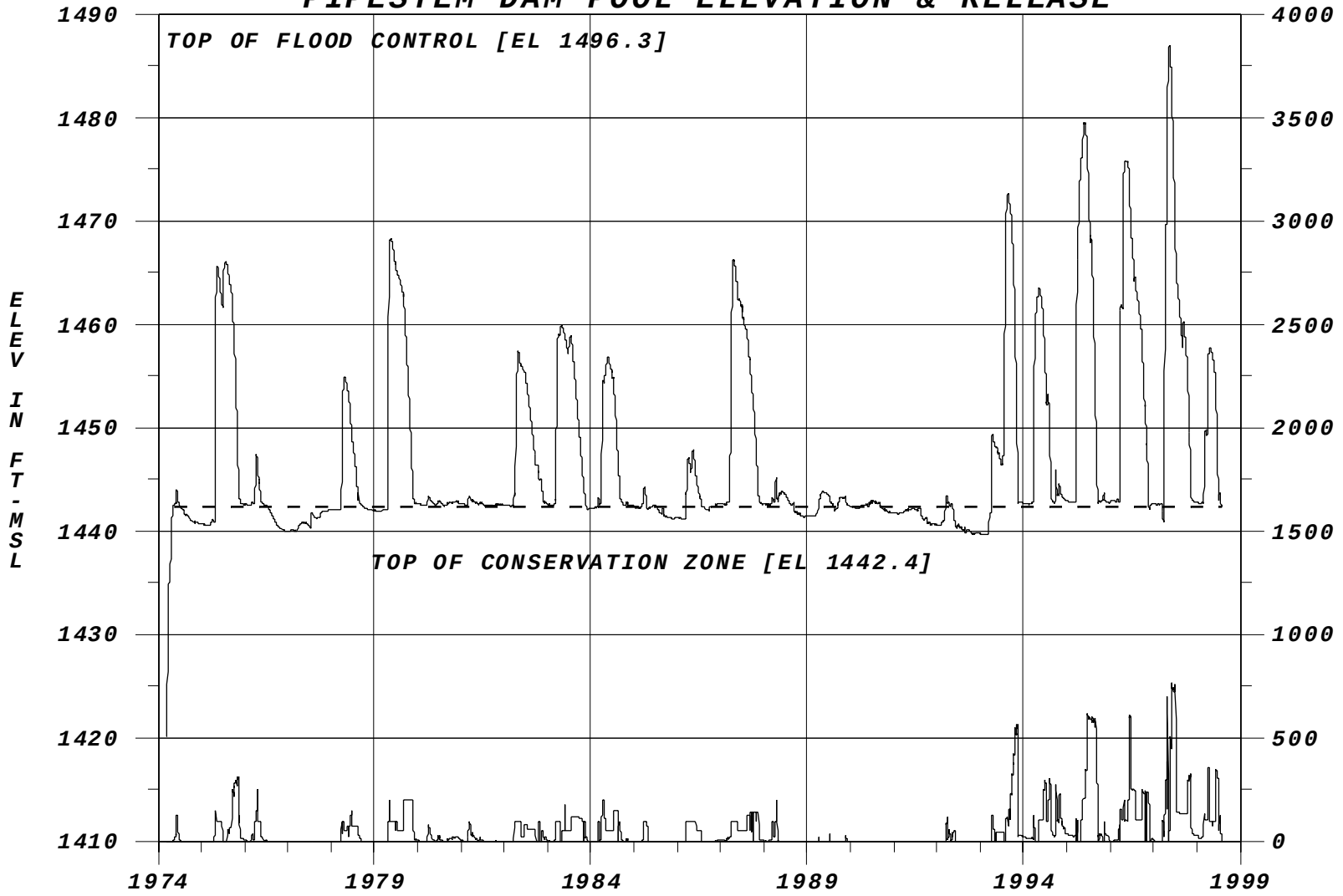


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

PIPESTEM DAM POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

OLIVE CREEK DAM AND LAKE
SALT CREEK BASIN - NO. 2, NEBRASKA
1997-1998 REGULATION

Olive Creek Reservoir is another of the projects the Nebraska Game and Parks Commission has earmarked for renovation. The renovation will include shoreline protection, sediment detention dams, and islands. On May 26, 1998, at the request of the Nebraska Game and Parks Commission, the low level gate was opened 1 foot for a maximum release of 35 cfs to begin lowering the lake to allow renovation in late 1998 or early 1999. The invert of the low level gate is at elevation 1330.0 ft-msl. Since the Nebraska Game and Parks Commission wanted the reservoir lower, they installed two 8-inch siphons to drain the lake further. It is estimated that the siphons will be able to lower the lake level to approximately elevation 1326.

A total of 596 acre-feet or 15% of the 3973 acre-feet flood pool was occupied at the maximum pool level of 1336.15 ft-msl on March 27, 1998.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	764 cfs Jun 12 84	179 cfs Jul 25 93
2nd	749 cfs oct 10 73	176 cfs Oct 12 73
3rd	730 cfs Oct 11 86	171 cfs Jun 13 84

	Pool-Date
Highest	1342.62 Jul 24 93
2nd	1342.6 Oct 11 73
3rd	1342.6 Jun 12 84

Minimums of Record (since initial fill):

	Pool-Date
Lowest	1326.63 Oct 28 91
2nd	1326.31 Jul 04 92

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
3,920, 162% of normal

Total Outflow (AF)
4,142, 226% of normal

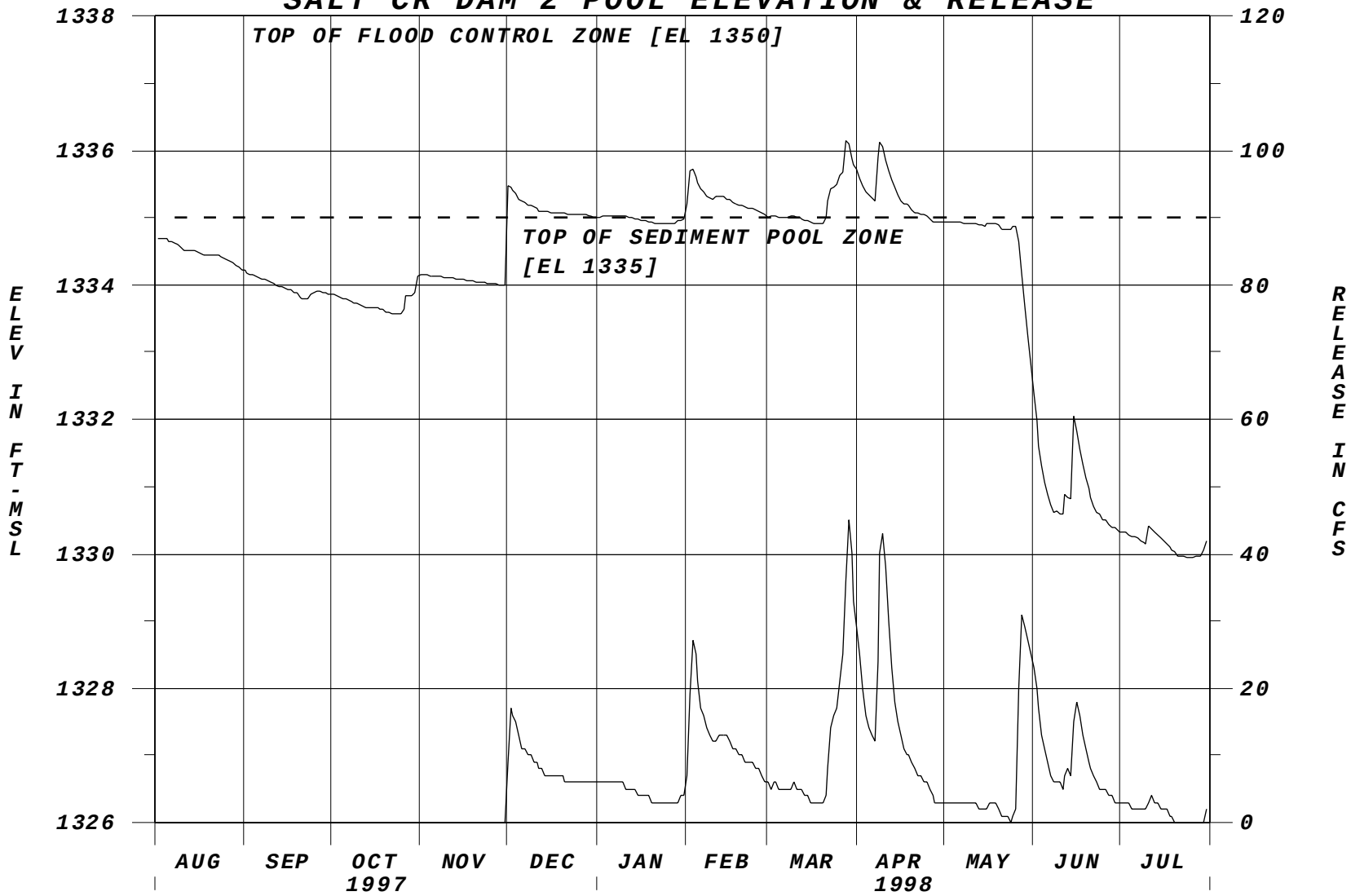
Peak Daily Inflow (CFS)
131, Nov 30

Peak Daily Outflow (CFS)
45, Mar 28

Peak Pool Elevation (FT-MSL)
1336.15, Mar 27

Minimum Pool Elevation (FT-MSL)
1329.94, Jul 25

SALT CR DAM 2 POOL ELEVATION & RELEASE

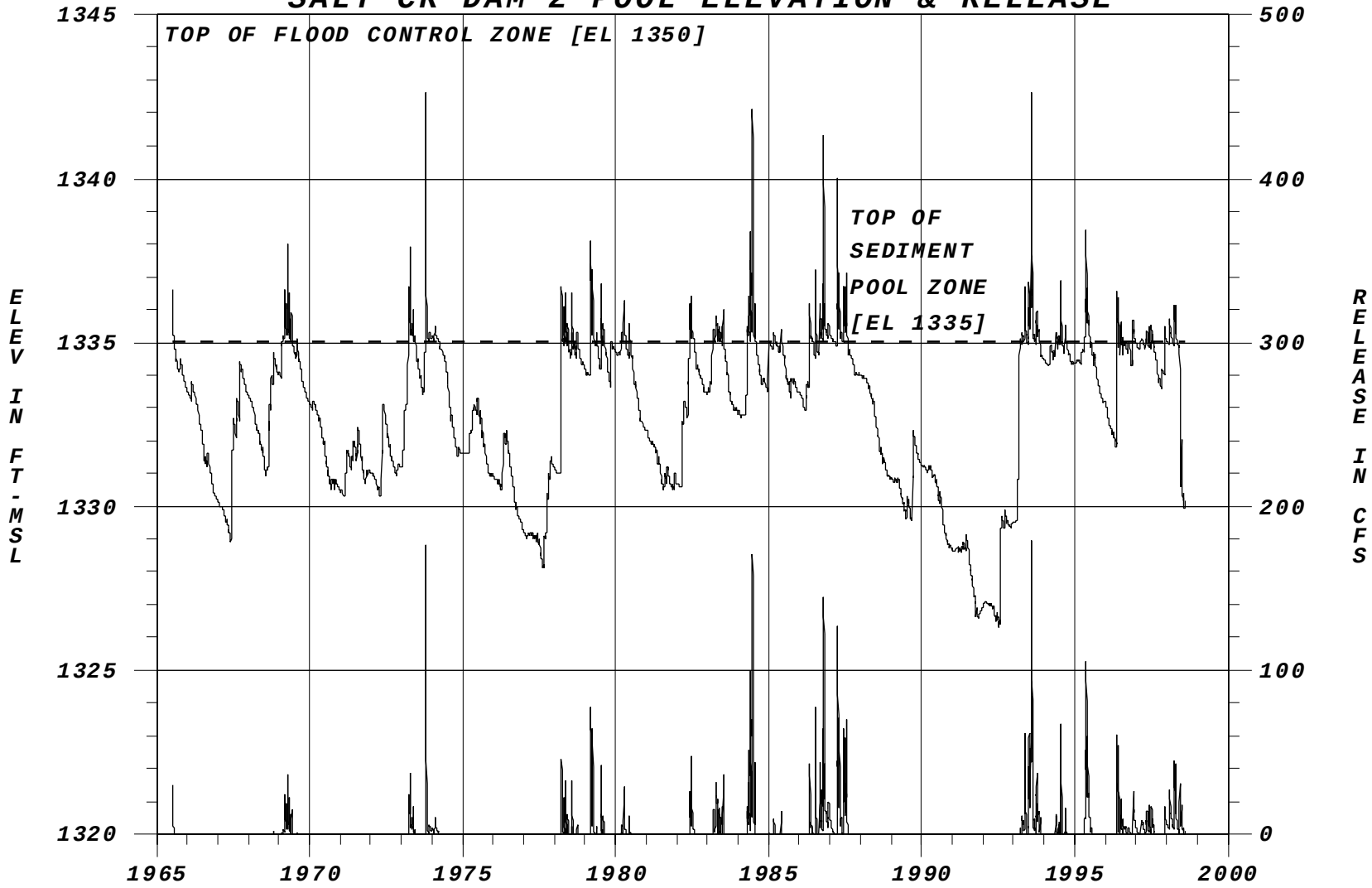


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

SALT CR DAM 2 POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

BLUESTEM DAM AND LAKE
SALT CREEK BASIN - NO. 4, NEBRASKA
1997-1998 REGULATION

The pool level started the report period below the flood control zone. It was in the flood control zone briefly in early December, most of February, late March through late April and June through July. The peak pool level for the report period was 1309.42 ft-msl on June 14th.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	1,477 cfs Oct 10 73	342 cfs Oct 12 73
2nd	996 cfs May 09 96	198 cfs Jun 13 84
3rd	932 cfs Jul 23 93	195 cfs Jul 26 93

	Pool-Date
Highest	1316.5 Oct 11 73
2nd	1314.5 Jun 13 84
3rd	1314.23 Jul 25 93

Minimums of Record (since initial fill):

	Pool-Date
Lowest	1299.46 May 31 92
2nd	1299.77 Nov 13 91

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
5,480, 118% of normal

Total Outflow (AF)
4,643, 135% of normal

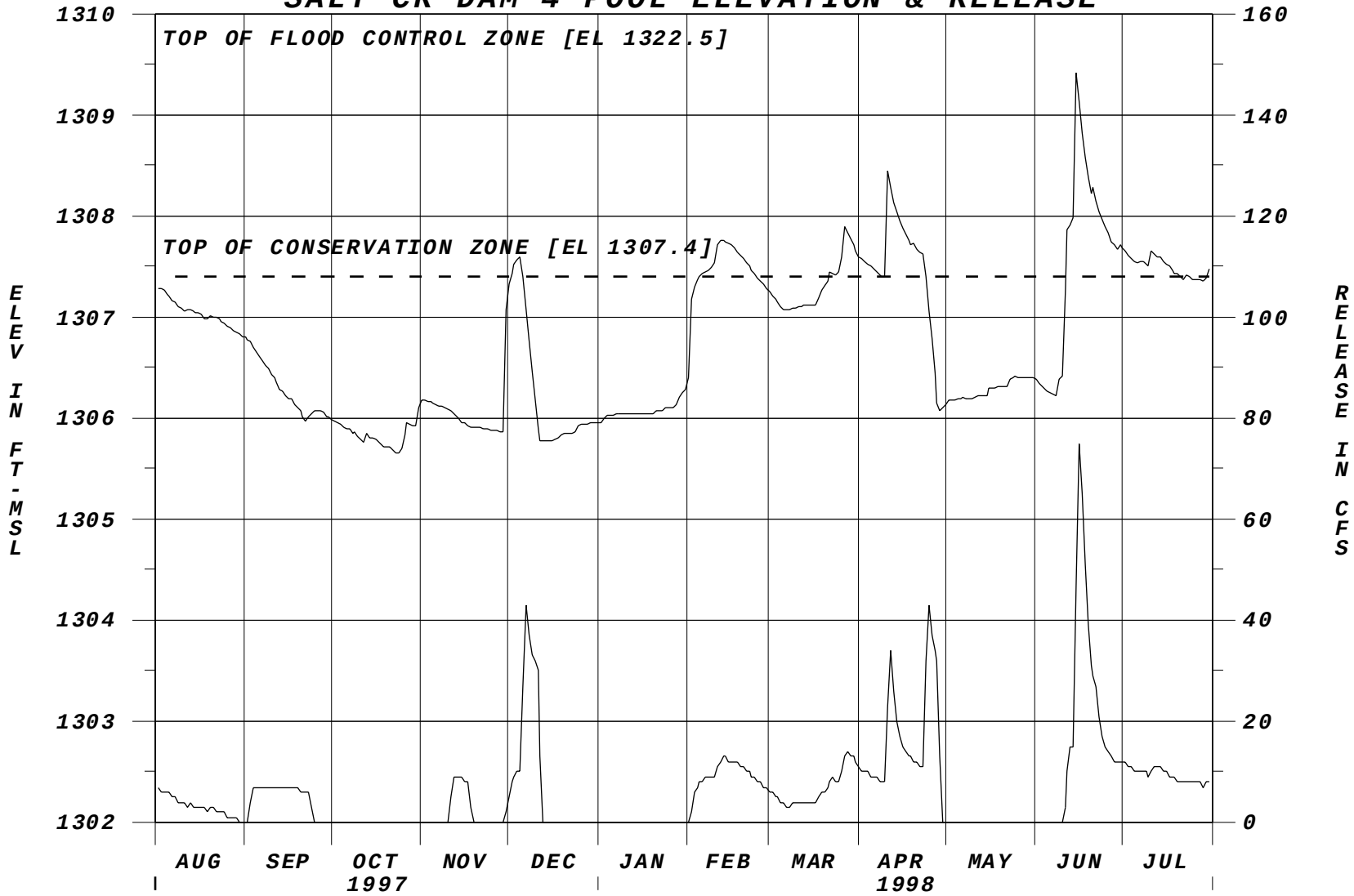
Peak Daily Inflow (CFS)
290, Jun 14

Peak Daily Outflow (CFS)
75, Jun 15

Peak Pool Elevation (FT-MSL)
1309.42, Jun 14

Minimum Pool Elevation (FT-MSL)
1305.65, Oct 22

SALT CR DAM 4 POOL ELEVATION & RELEASE

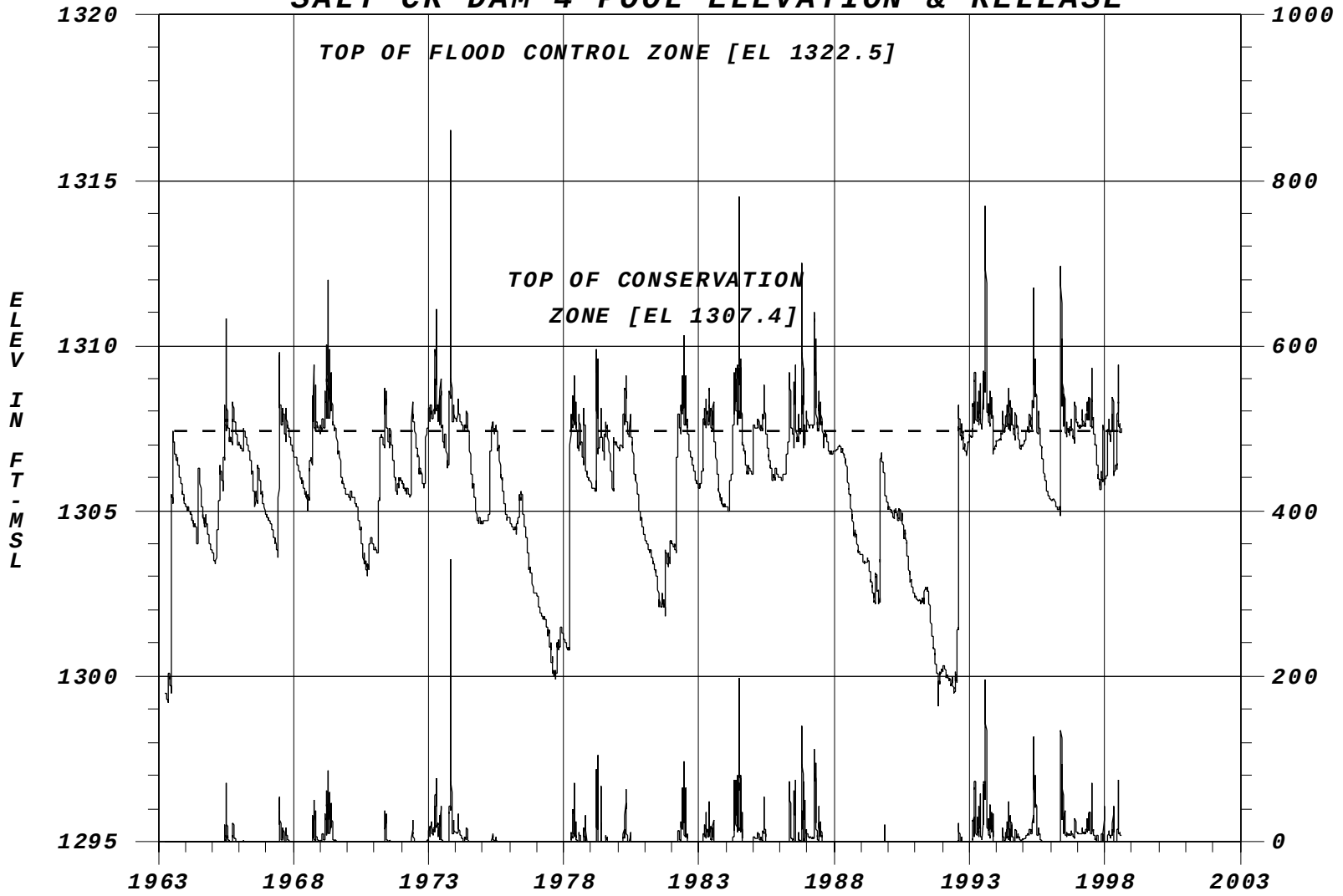


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

SALT CR DAM 4 POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

WAGON TRAIN DAM AND LAKE
SALT CREEK BASIN - NO. 8, NEBRASKA
1997-1998 REGULATION

Lowering of Wagon Train Lake began in September 1997. Nebraska Game and Parks Commission plans are to renovate the lake and develop shoreline protection, sediment detention and island habitat during the winter of 1998-1999. The lake will be lowered to approximately 1275.0 ft-msl. There is also a proposal to modify the outlet works so that the lake level can be maintained below top of conservation. Plans are currently being reviewed.

Except for the beginning of the reporting period, due to the draw down request, the pool did not climb into the flood control pool.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	1,199 cfs Oct 10 73	334 cfs Jul 25 93
2nd	1,037 cfs Jul 24 93	329 cfs Oct 12 73
3rd	1,027 cfs Oct 11 86	175 cfs Oct 12 86

	Pool-Date
Highest	1295.4 Oct 11 73
2nd	1294.61 Jul 25 93
3rd	1293.2 Jun 13 84
	Oct 11 86

Minimums of Record (since initial fill):

	Pool-Date
Lowest	1280.78 Sep 30 98*
2nd	1281.72 Nov 01 91

*Due to lake renovation and habitat enhancement.

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
12,212, 240% of normal

Total Outflow (AF)
12,804, 314% of normal

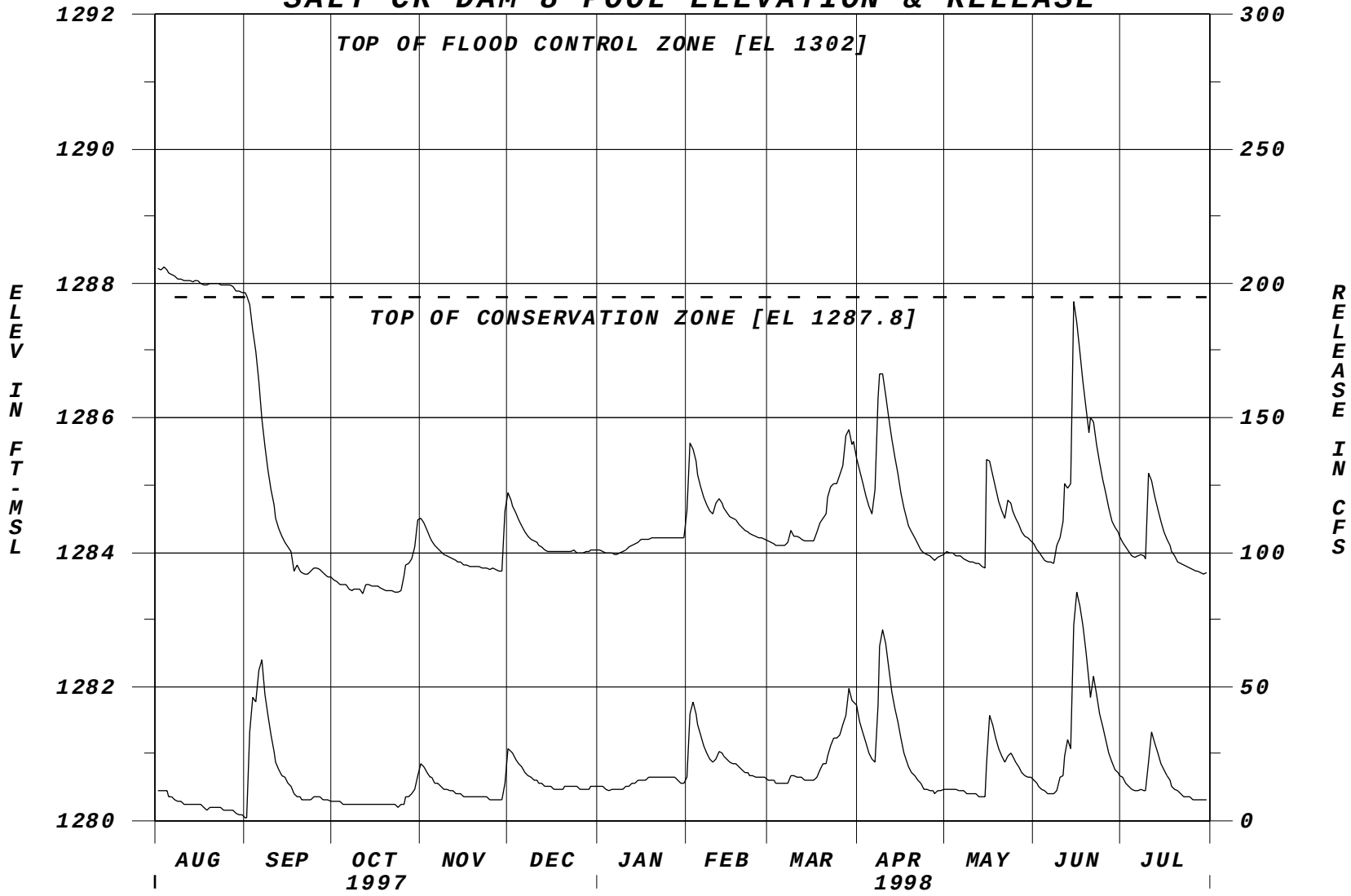
Peak Daily Inflow (CFS)
440, Jun 14

Peak Daily Outflow (CFS)
85, Jun 15

Peak Pool Elevation (FT-MSL)
1288.24, Aug 03

Minimum Pool Elevation (FT-MSL)
1283.39, Oct 11

SALT CR DAM 8 POOL ELEVATION & RELEASE

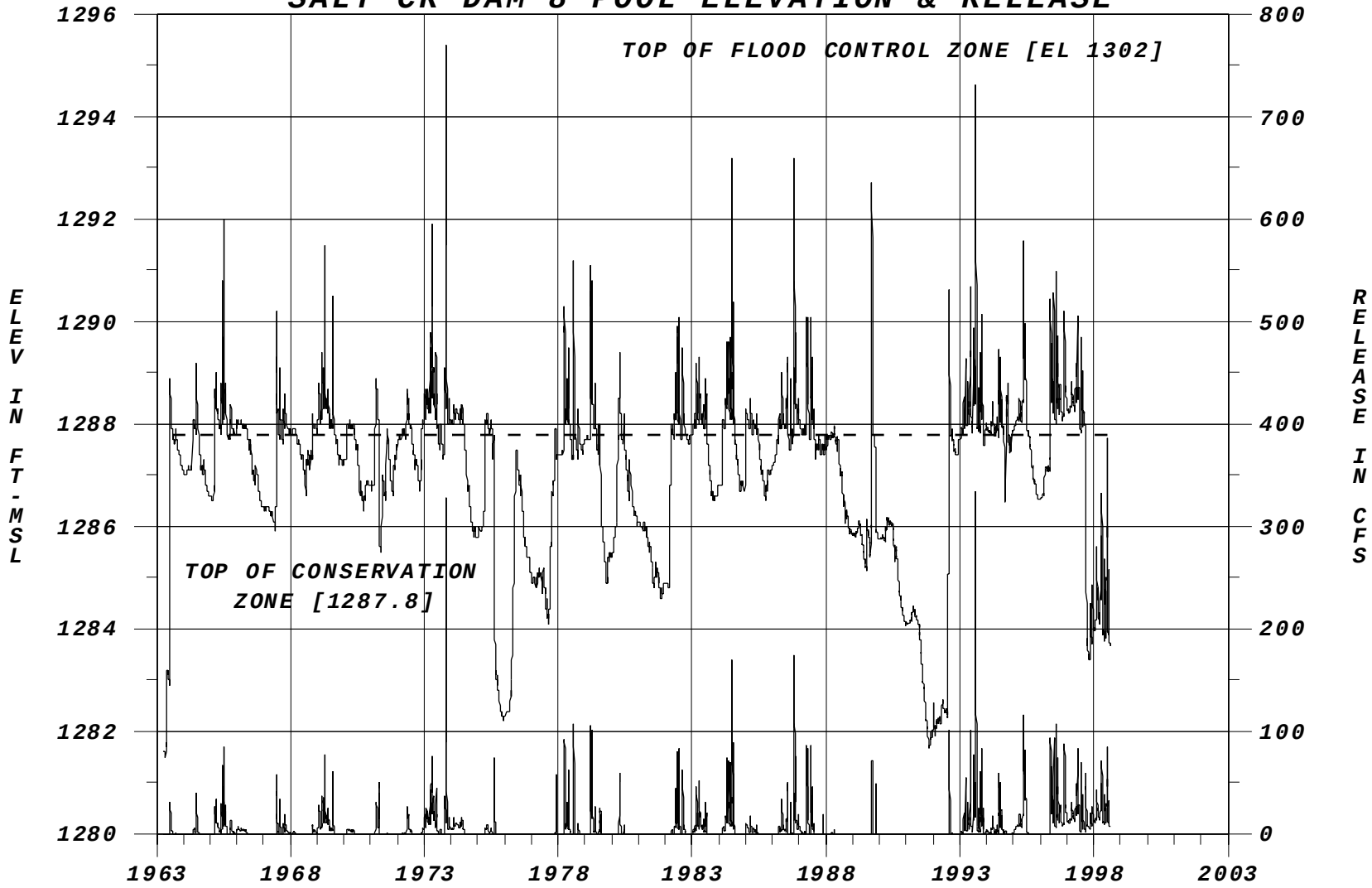


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

SALT CR DAM 8 POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

STAGECOACH DAM AND LAKE
SALT CREEK BASIN - NO. 9, NEBRASKA
1997-1998 REGULATION

The pool level entered the flood control zone in late October and remained there for the rest of the report period.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	958 cfs Oct 10 73	190 cfs Oct 12 73
2nd	829 cfs Oct 11 86	155 cfs Jul 25 93
3rd	776 cfs Jul 24 93	127 cfs May 10 96

	Pool-Date
Highest	1279.0 Oct 11 73
2nd	1278.15 Jul 24 93
3rd	1277.7 May 09 96

Minimums of Record (since initial fill):

	Pool-Date
Lowest	1259.60 Oct 31 91
2nd	1260.5 Aug 09 76

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
8,805, 274% of normal

Total Outflow (AF)
8,247, 330% of normal

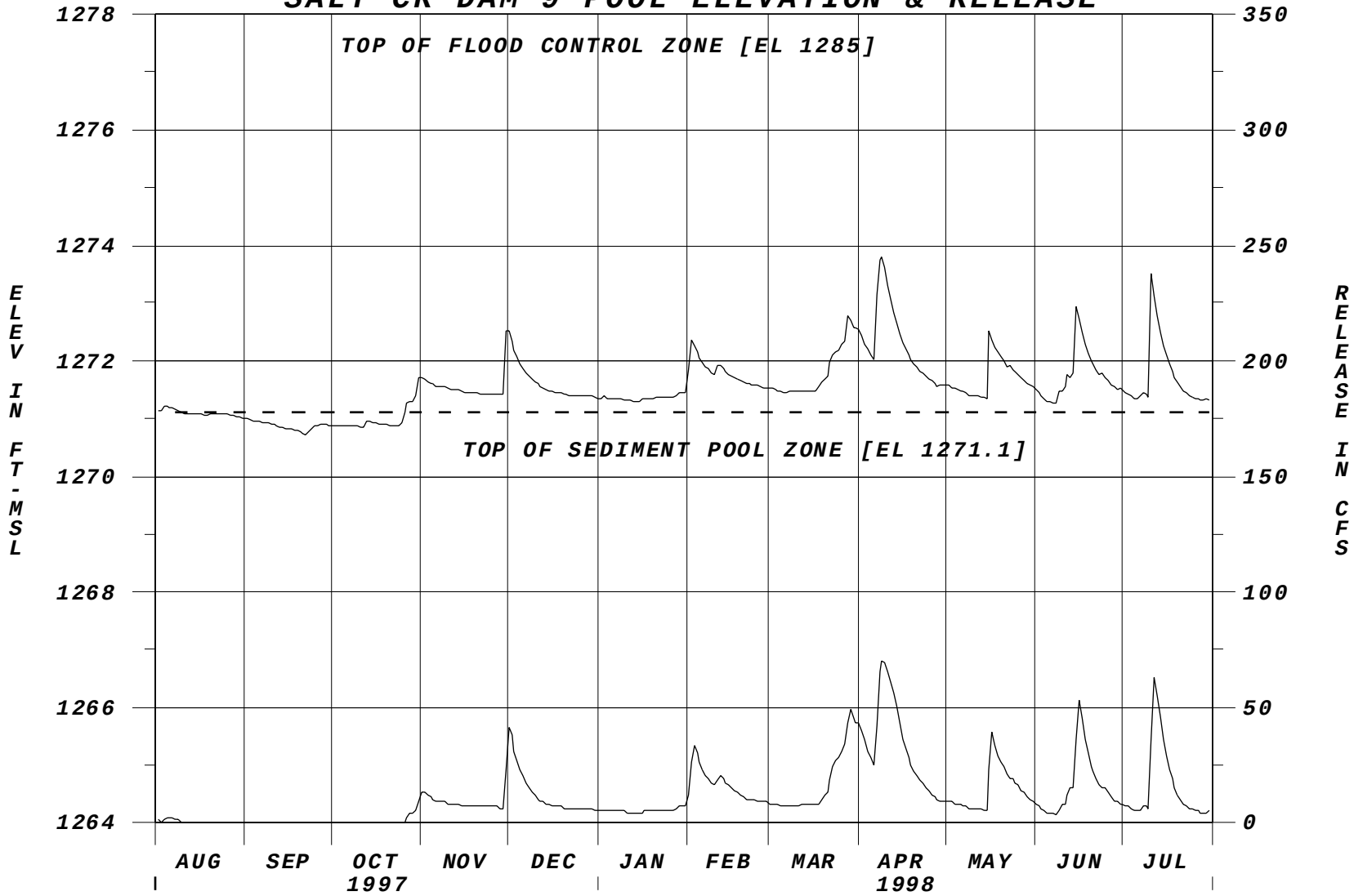
Peak Daily Inflow (CFS)
276, Jul 10

Peak Daily Outflow (CFS)
70, Apr 08

Peak Pool Elevation (FT-MSL)
1273.79, Apr 08

Minimum Pool Elevation (FT-MSL)
1270.71, Sep 20

SALT CR DAM 9 POOL ELEVATION & RELEASE

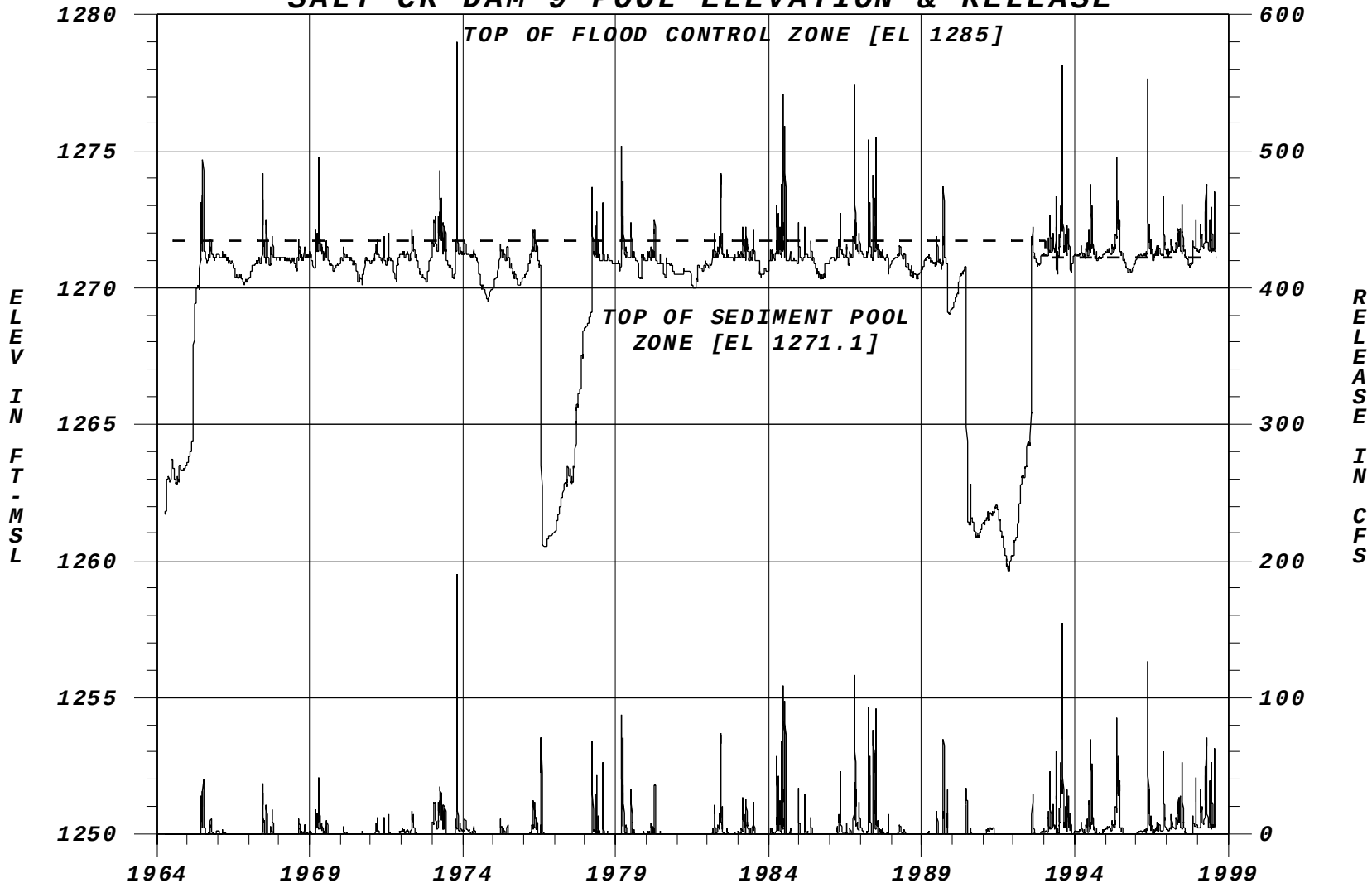


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

SALT CR DAM 9 POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

YANKEE HILL DAM AND LAKE
SALT CREEK BASIN - NO. 10, NEBRASKA
1997-1998 REGULATION

The pool level started the report period below the flood control zone. It entered the flood control zone in December and remained there for the rest of the reporting period.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	690 cfs Oct 10 73	145 cfs Oct 12 73
2nd	609 cfs Jul 24 93	133 cfs Jul 25 93
3rd	575 cfs Sep 08 89	114 cfs Jun 14 84

	Pool-Date
Highest	1252.3 Oct 11 73
2nd	1251.21 Jul 24 93
3rd	1250.7 Jun 13 84

Minimums of Record (since initial fill):

	Pool-Date
Lowest	1238.9 Aug 08 77
2nd	1239.1 Sep 19 81

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
12,581, 240% of normal

Total Outflow (AF)
11,920, 263% of normal

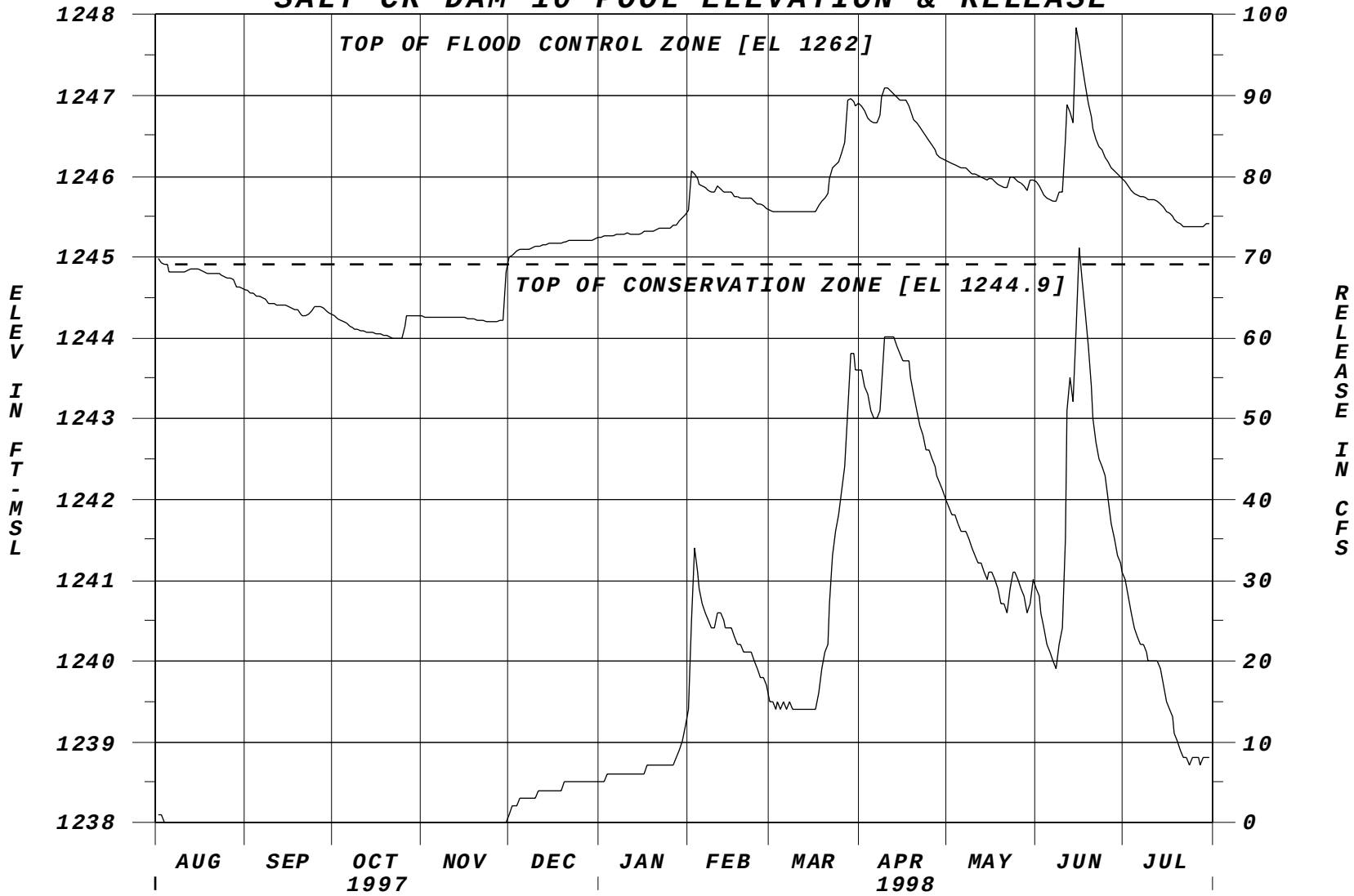
Peak Daily Inflow (CFS)
211, Jun 14

Peak Daily Outflow (CFS)
71, Jun 15

Peak Pool Elevation (FT-MSL)
1247.84, Jun 14

Minimum Pool Elevation (FT-MSL)
1243.98, Oct 21

SALT CR DAM 10 POOL ELEVATION & RELEASE

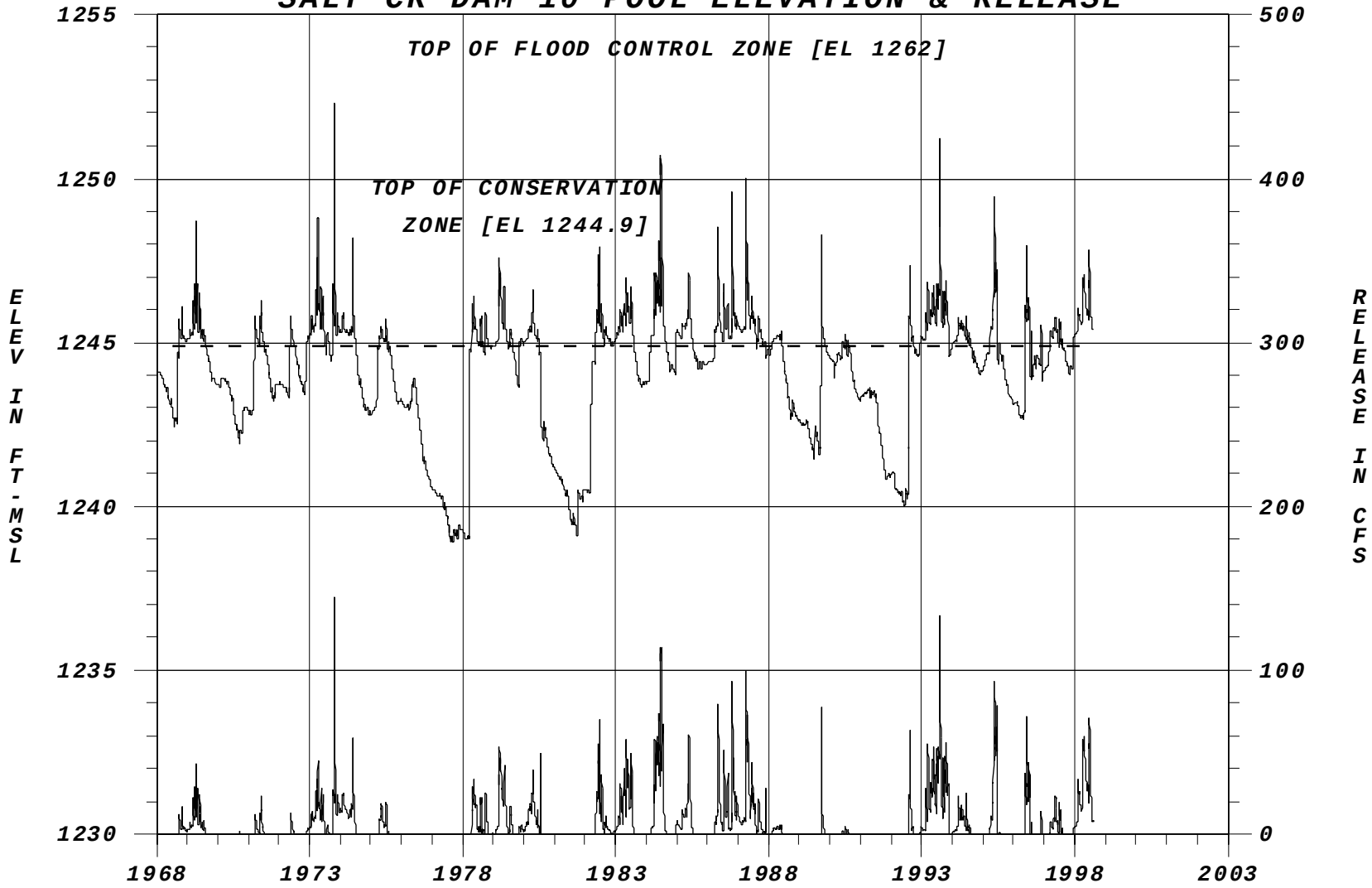


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

SALT CR DAM 10 POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

CONESTOGA DAM AND LAKE
SALT CREEK BASIN - NO. 12, NEBRASKA
1997-1998 REGULATION

Since July of 1996, Conestoga has been operated to facilitate fish habitat enhancement with a 2.5 feet draw down, per a request from the Nebraska Game and Parks Commission. This operation involves drawing the reservoir down 2.5 feet during mid to late summer. The Nebraska Game and Parks Commission then seeds the exposed shoreline with millet and other flood tolerant species. The lake level is maintained 2.5 feet low until early the next spring, when spring inflows are captured and the lake returns to normal levels, flooding the mature vegetation. The flooded vegetation offers fish habitat for spawning and cover. It is too early to tell if this operation is of much benefit, however, according to Nebraska Game and Parks Commission biologists, the practice seems to be improving some fish populations.

A June storm caused the pool to rise 3 feet, utilizing 1568 acre-feet or 20% of the 7840 acre-feet flood control zone.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	907 cfs Mar 24 87	185 cfs Mar 25 87
2nd	899 cfs Jul 24 93	180 cfs Jul 25 93
3rd	661 cfs Jun 27 83	152 cfs Jun 16 82

	Pool-Date
Highest	1241.1 Mar 24 87
2nd	1240.63 Jul 24 93
3rd	1239.6 Oct 11 73

Minimums of Record (since initial fill):

	Pool-Date
Lowest	1228.4 Aug 28 77
2nd	1229.12 Jun 30 92

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
6,541, 119% of normal

Total Outflow (AF)
6,324, 134% of normal

Peak Daily Inflow (CFS)
406, Jun 14

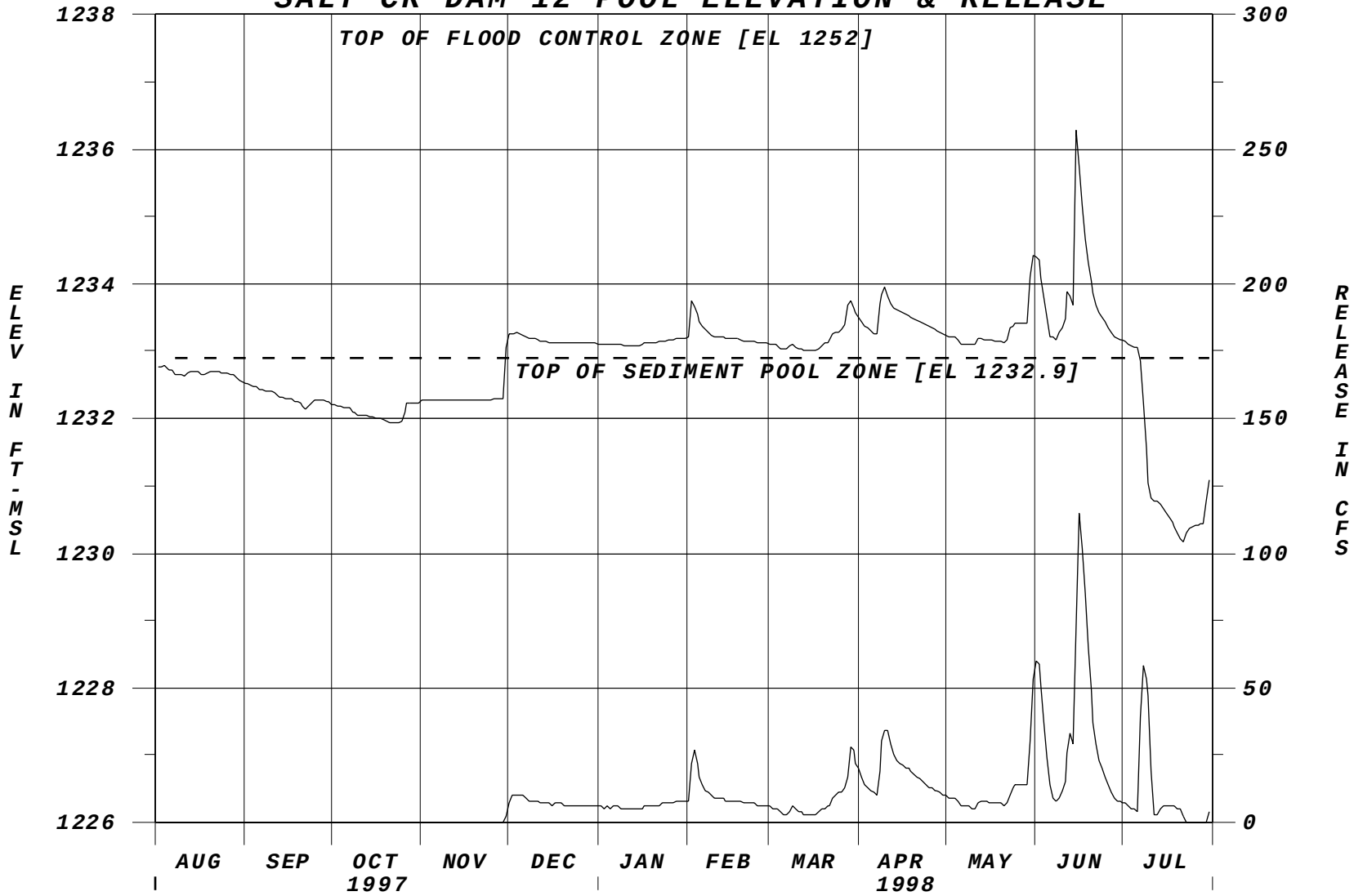
Peak Daily Outflow (CFS)
115, Jun 15

Peak Pool Elevation (FT-MSL)
1236.27, Jun 14

Minimum Pool Elevation (FT-MSL)
1230.16, Jul 21*

*Pool lowered 2 feet to facilitate fish habitat enhancements.

SALT CR DAM 12 POOL ELEVATION & RELEASE

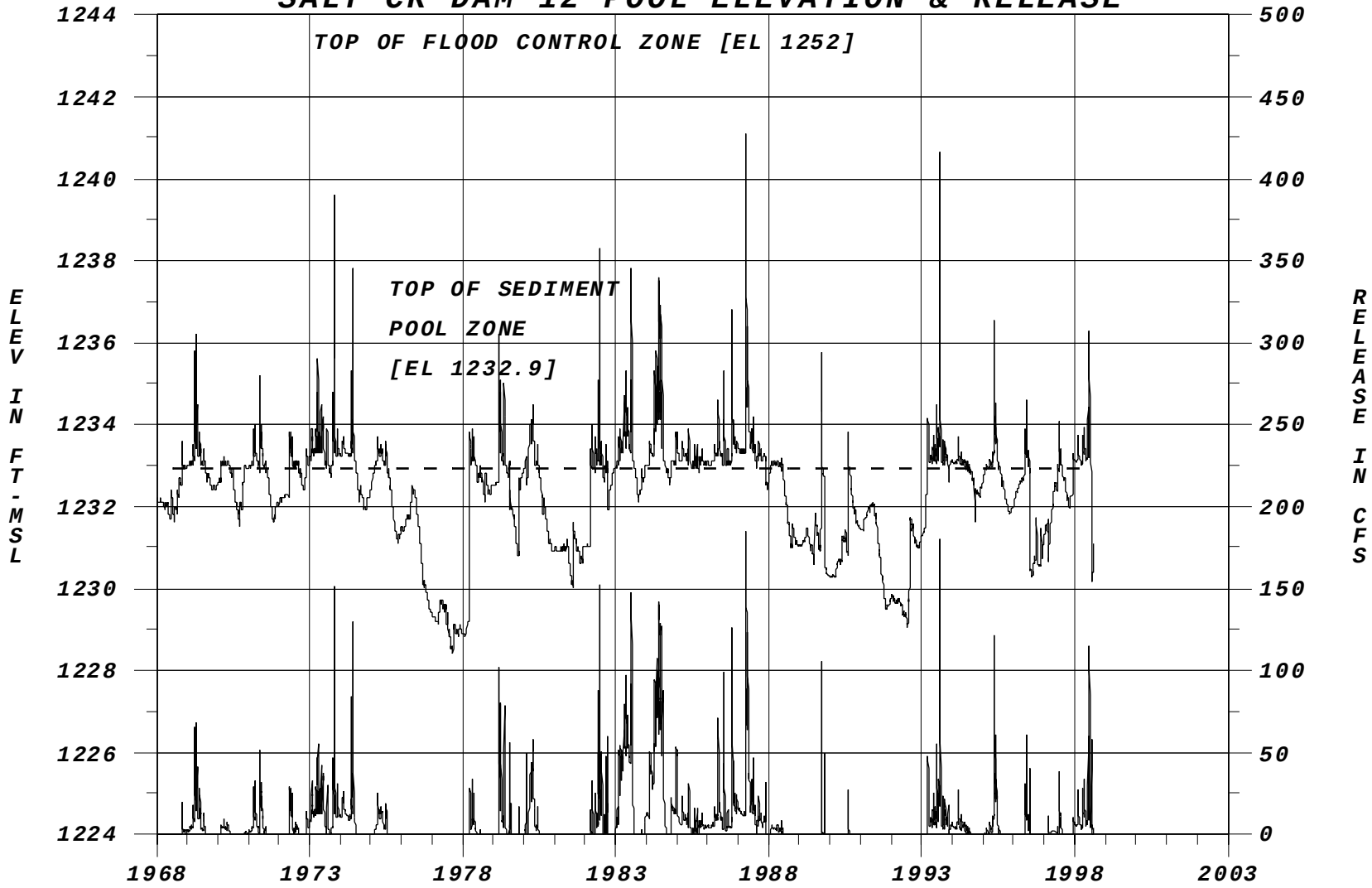


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

SALT CR DAM 12 POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

TWIN LAKES DAM AND LAKE
SALT CREEK BASIN - NO. 13, NEBRASKA
1997-1998 REGULATION

The pool level started the report period below the flood control zone due to shoreline seeding for crappie habitat by the Nebraska Game and Parks Commission. It entered the flood control zone in April and remained there for the rest of the reporting period.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	632 cfs Jul 13 93	168 cfs Jun 30 83
2nd	539 cfs Mar 23 87	167 cfs Mar 24 87
3rd	539 cfs Jun 14 98	165 cfs Jul 27 93

	Pool-Date
Highest	1346.9 Jun 29 83
2nd	1346.0 Mar 23 87
3rd	1345.55 Jul 26 93

Minimums of Record (since initial fill):

	Pool-Date
Lowest	1332.13 Oct 31 91
2nd	1332.2 Aug 18 89

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
7,177, 174% of normal

Total Outflow (AF)
5,945, 181% of normal

Peak Daily Inflow (CFS)
539, Jun 14

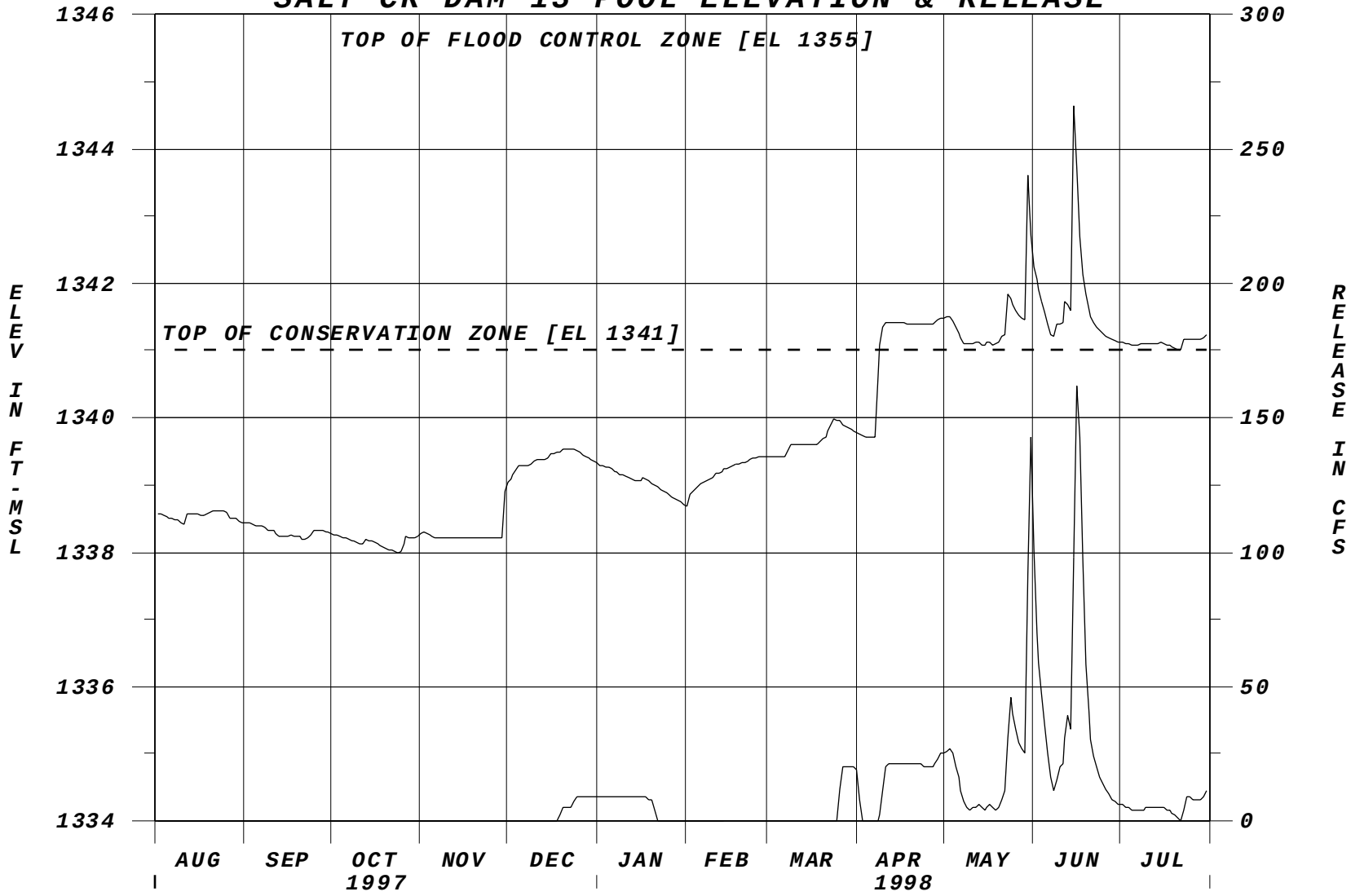
Peak Daily Outflow (CFS)
162, Jun 15

Peak Pool Elevation (FT-MSL)
1344.65, Jun 14

Minimum Pool Elevation (FT-MSL)
1337.98, Oct 23 *

*Due to pool draw down for fish habitat work.

SALT CR DAM 13 POOL ELEVATION & RELEASE

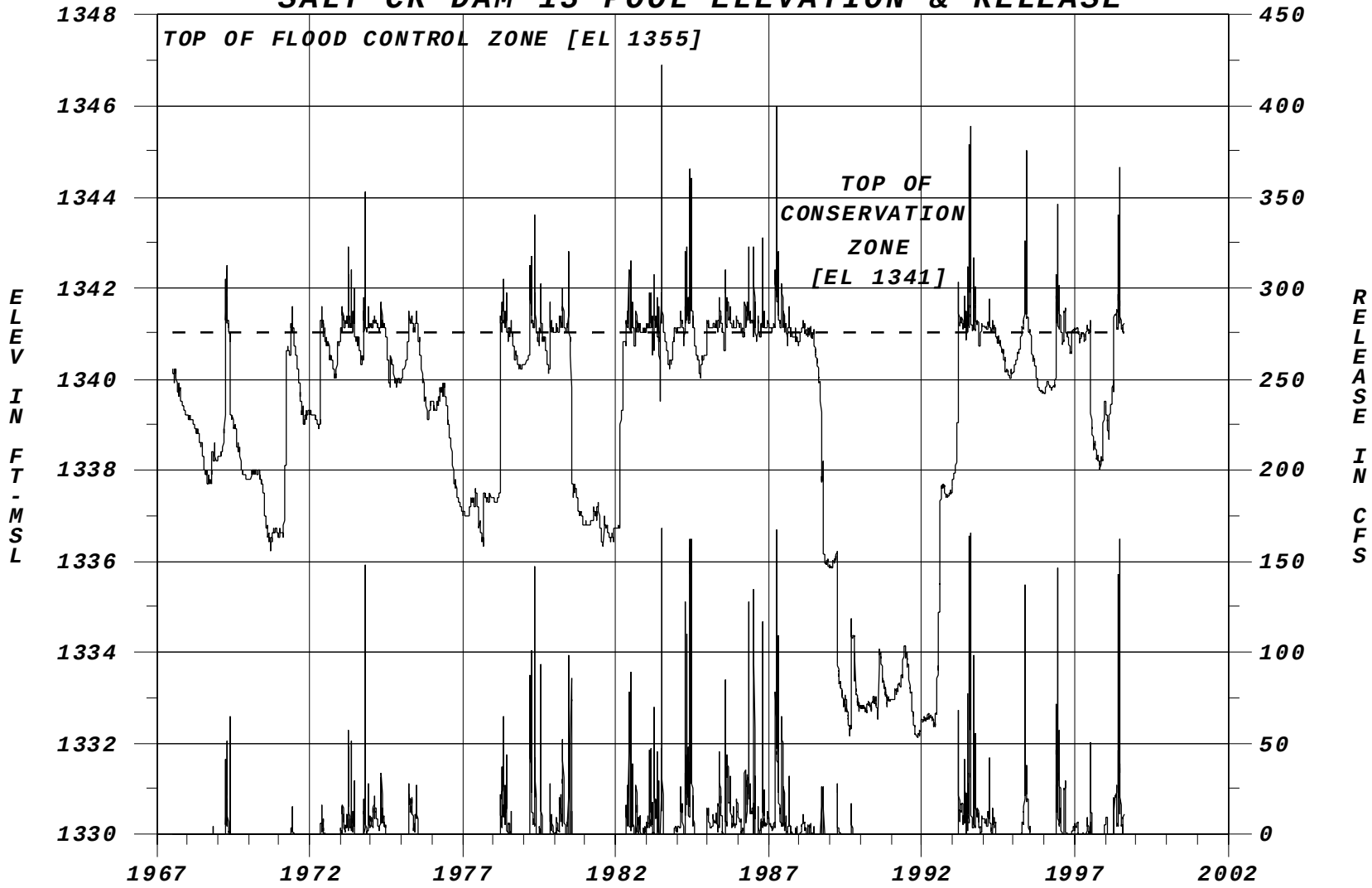


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

SALT CR DAM 13 POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

PAWNEE DAM AND LAKE
SALT CREEK BASIN - NO. 14, NEBRASKA
1997-1998 REGULATION

Pool levels were below the flood control zone for most of the report period. A 2 plus inch storm in June caused the pool to rise almost 3 feet.

A total of 2130 acre-feet or 10% of the 21,300 acre-feet flood control storage was utilized at the maximum pool level in June.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	1,381 cfs Mar 24 87	419 cfs Mar 25-26 87
2nd	1,347 cfs Jul 13 93	420 cfs Jul 25 93
3rd	1,074 cfs Jul 19 85	311 cfs Jun 13 84

	Pool-Date
Highest	1249.9 Jul 25 93
2nd	1248.4 Mar 24-25, 27 87
3rd	1247.1 Jun 12 84

Minimums of Record (since initial fill):

	Pool-Date
Lowest	1240.2 Oct 14 79
2nd	1241.2 Jan 01 77

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
9,117, 113% of normal

Total Outflow (AF)
6,548, 119% of normal

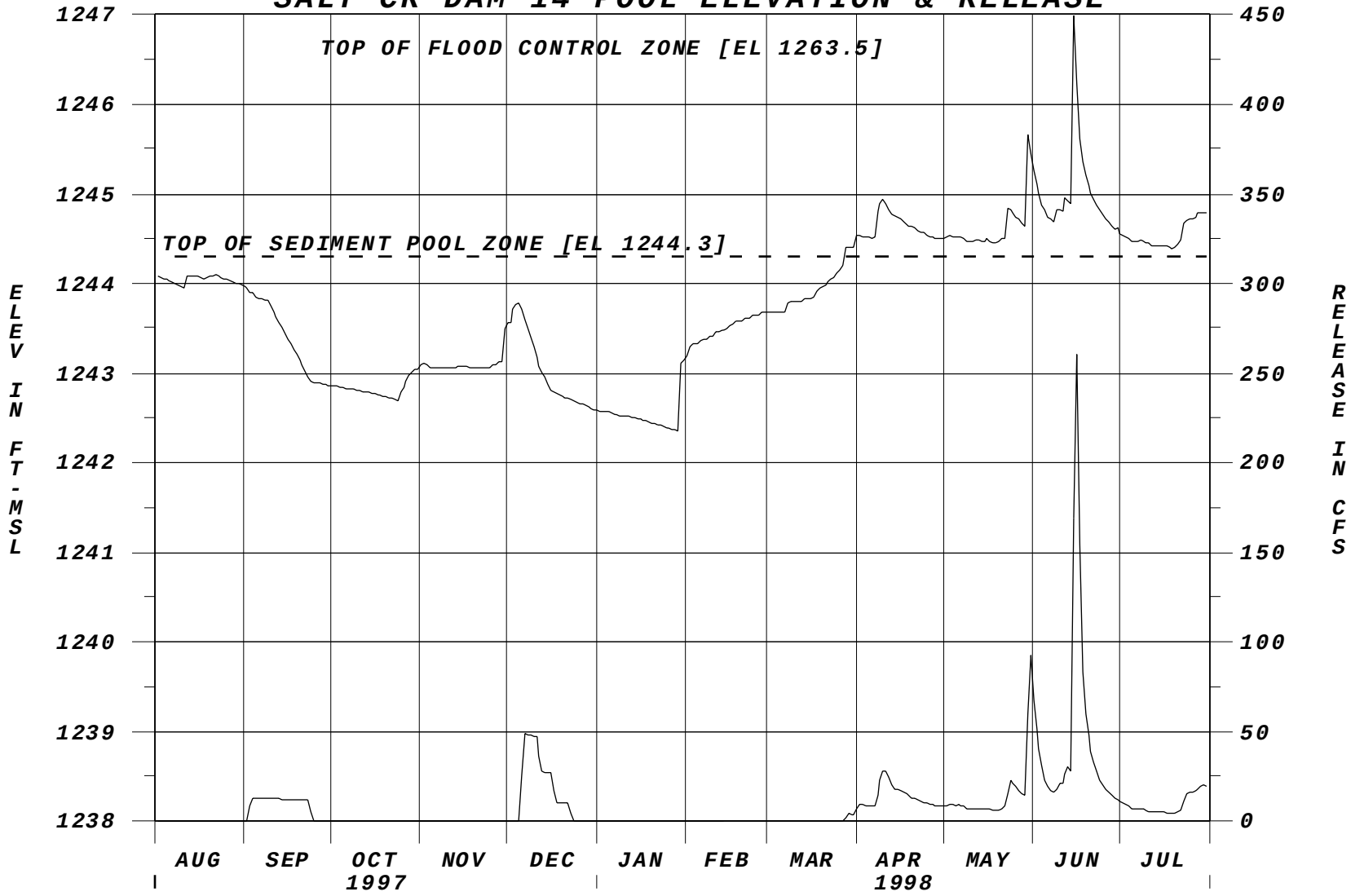
Peak Daily Inflow (CFS)
884, Jun 14

Peak Daily Outflow (CFS)
260, Jun 15

Peak Pool Elevation (FT-MSL)
1,246.98 Jun 14

Minimum Pool Elevation (FT-MSL)
1,242.35, Jan 28

SALT CR DAM 14 POOL ELEVATION & RELEASE

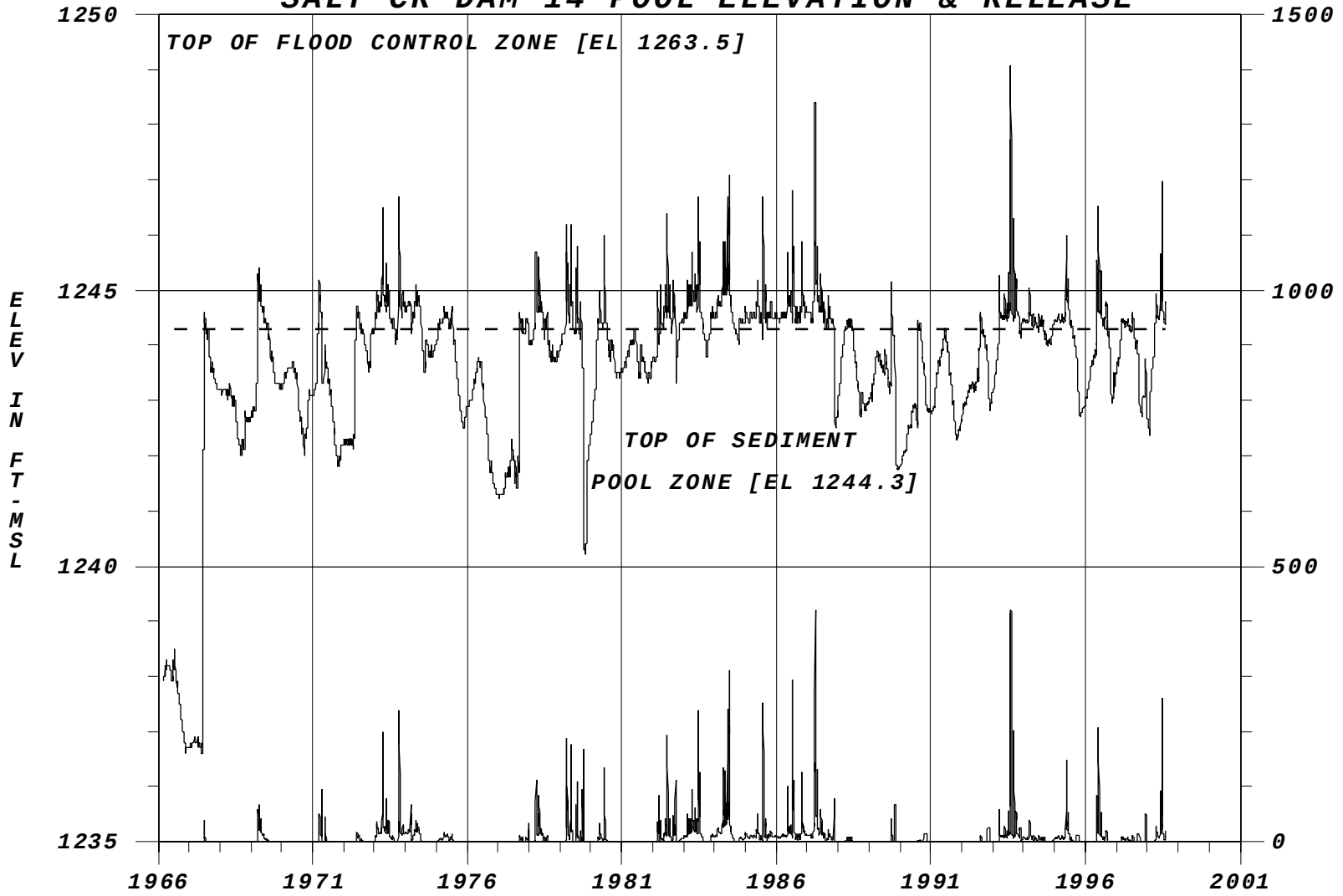


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

SALT CR DAM 14 POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

ANTELOPE CREEK DAM AND HOLMES PARK LAKE
SALT CREEK BASIN - NO. 17, NEBRASKA
1997-1998 REGULATION

The pool level remained in or very near the flood control zone during the report period. However, inflows were very much above normal over the report period.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	604 cfs Jul 24 93	187 cfs Jun 29 83
2nd	567 cfs Sep 08 89	174 cfs Jul 25 93
3rd	451 cfs Jul 20 96	140 cfs Sep 09 89

	Pool-Date
Highest	1249.97 Jul 24 93
2nd	1249.1 Sep 08 89
3rd	1248.1 Jun 27 83

Minimums of Record (since initial fill):

	Pool-Date
Lowest	1232.9 Aug 03 77
2nd	1236.8 Feb 26 76

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
8,914, 294% of normal

Total Outflow (AF)
8,545, 338% of normal

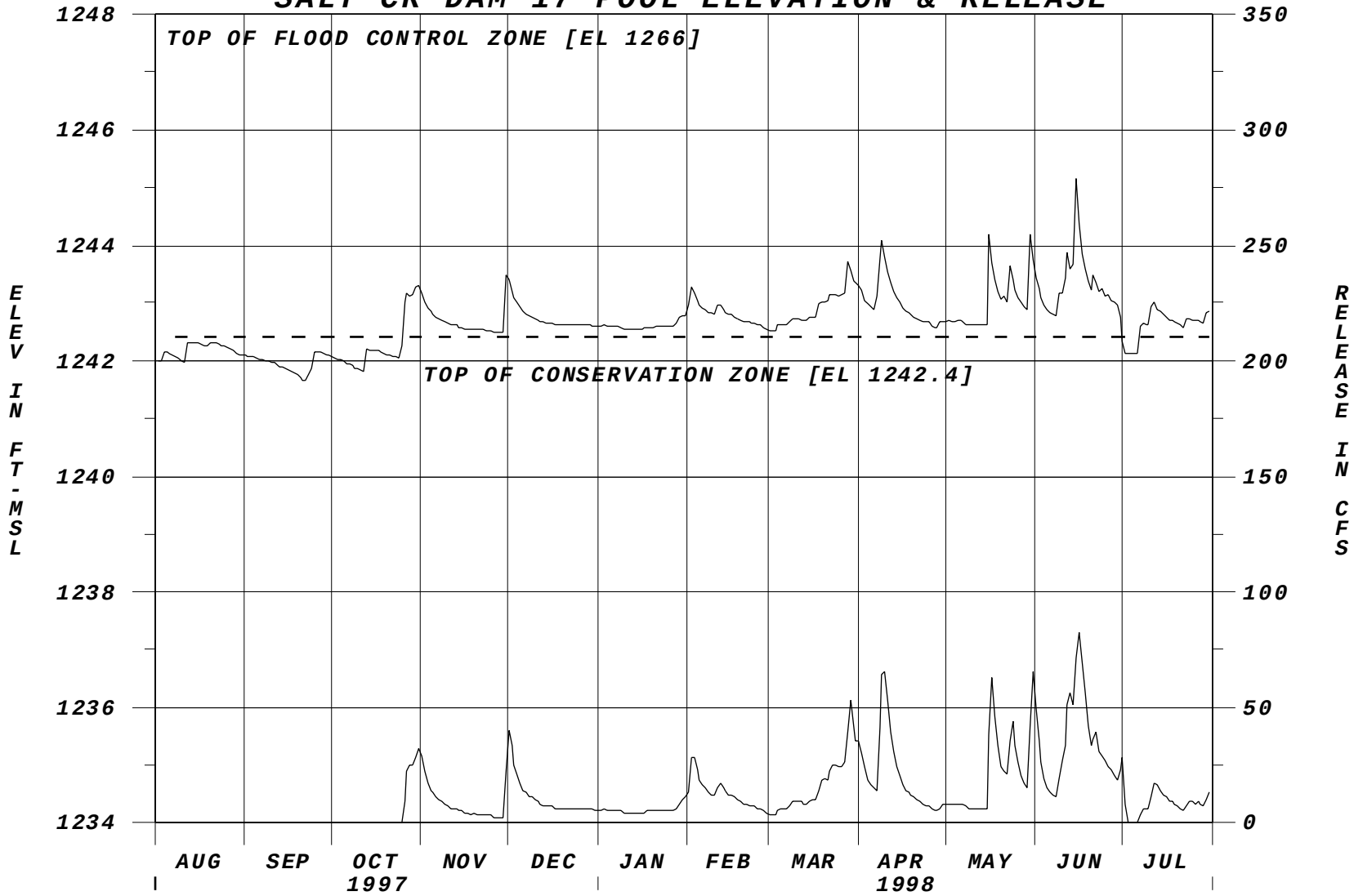
Peak Daily Inflow (CFS)
179, Jun 14

Peak Daily Outflow (CFS)
82, Jun 15

Peak Pool Elevation (FT-MSL)
1245.14, Jun 14

Minimum Pool Elevation (FT-MSL)
1241.65, Sep 21

SALT CR DAM 17 POOL ELEVATION & RELEASE

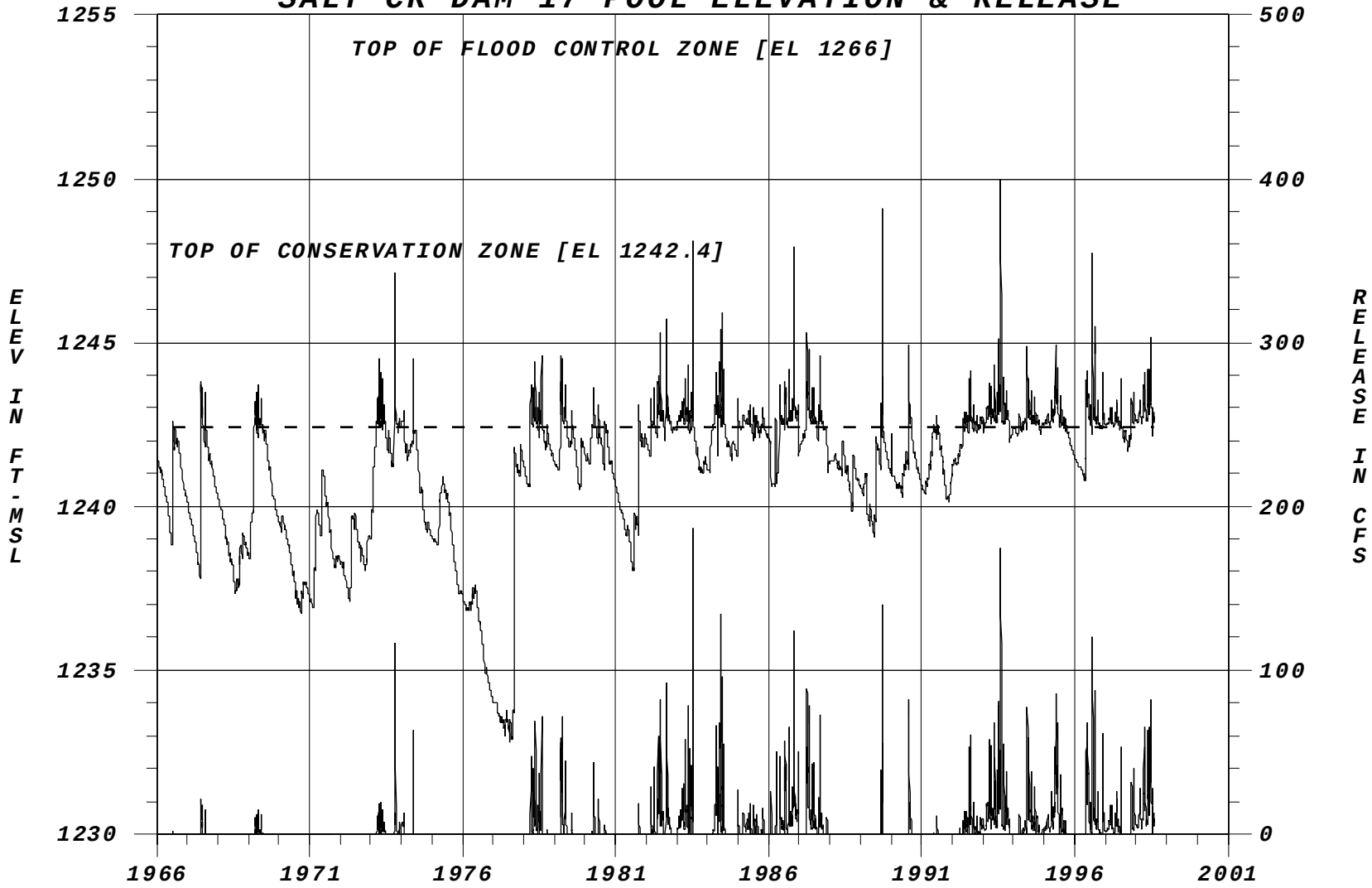


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

SALT CR DAM 17 POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

BRANCHED OAK DAM AND LAKE
SALT CREEK BASIN - NO. 18, NEBRASKA
1997-1998 REGULATION

The third highest inflow of record occurred on May 22nd, after rain of more than 2.5 inches occurred in the basin. The pool level rose to 1286.85 which occupied 5527 acre-feet or 8% of the 69,090 acre-feet flood pool volume. The Nebraska Game and Parks Commission has requested Branched Oak Lake be lowered to elevation 1279.0 ft-msl to facilitate shoreline protection work that will be done in January 1999.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	3,700 cfs Aug 25 87	774 cfs Jul 25 93
2nd	2,435 cfs Mar 23 87	730 cfs Aug 26 87
3rd	1,945 cfs May 22 98	670 cfs Jun 19 83

	Pool-Date
Highest	1287.9 Aug 26 87
2nd	1287.79 Jul 24 93
3rd	1287.7 Jun 18 83
	Mar 23 87

Minimums of Record (since initial fill):

	Pool-Date
Lowest	1280.9 Jan 01 77
2nd	1281.5 Nov 25 89

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
32,472, 110% of normal

Total Outflow (AF)
27,870, 121% of normal

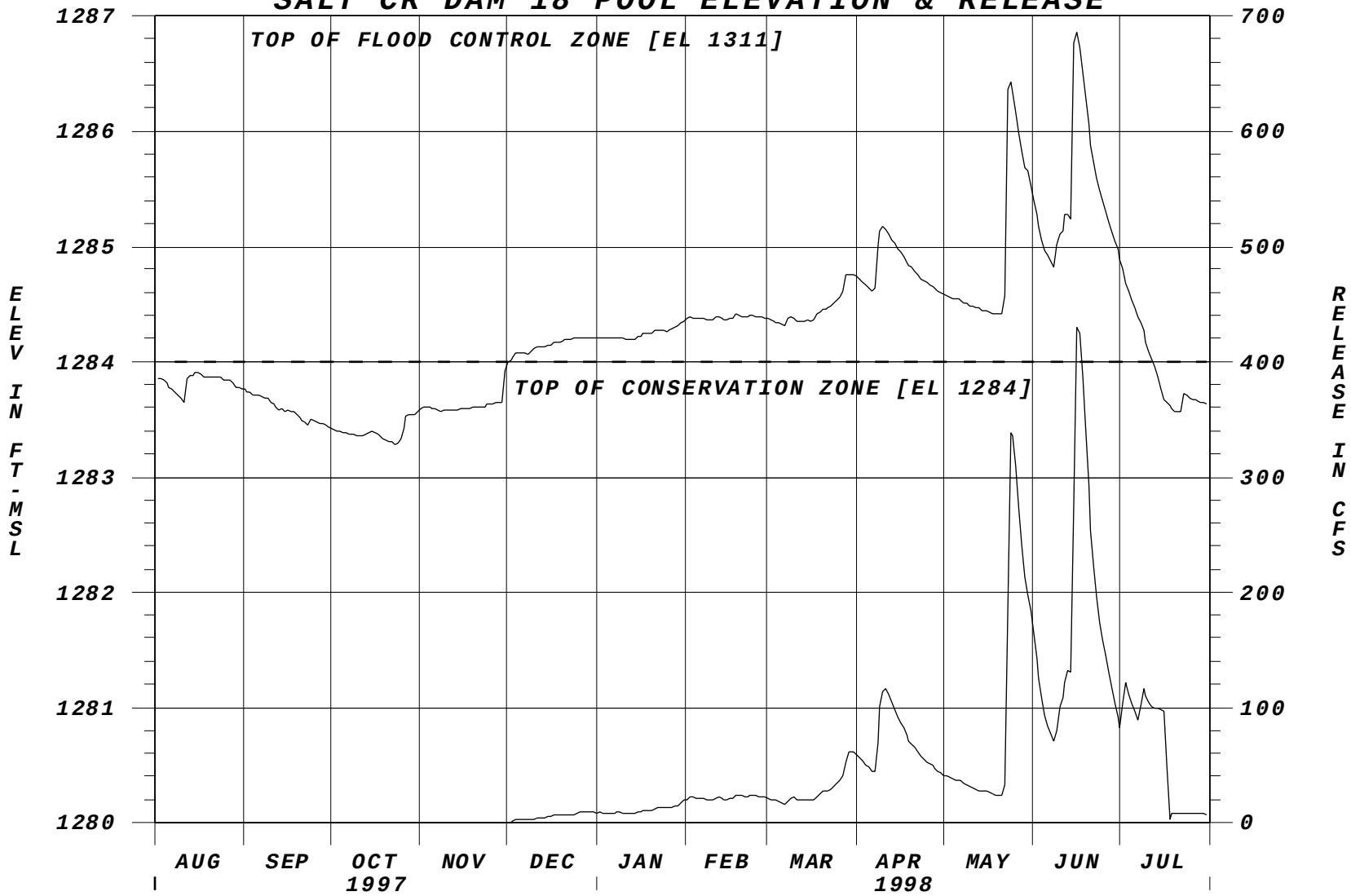
Peak Daily Inflow (CFS)
1945, May 22

Peak Daily Outflow (CFS)
430, Jun 15

Peak Pool Elevation (FT-MSL)
1286.85, Jun 15

Minimum Pool Elevation (FT-MSL)
1283.28, Oct 22

SALT CR DAM 18 POOL ELEVATION & RELEASE

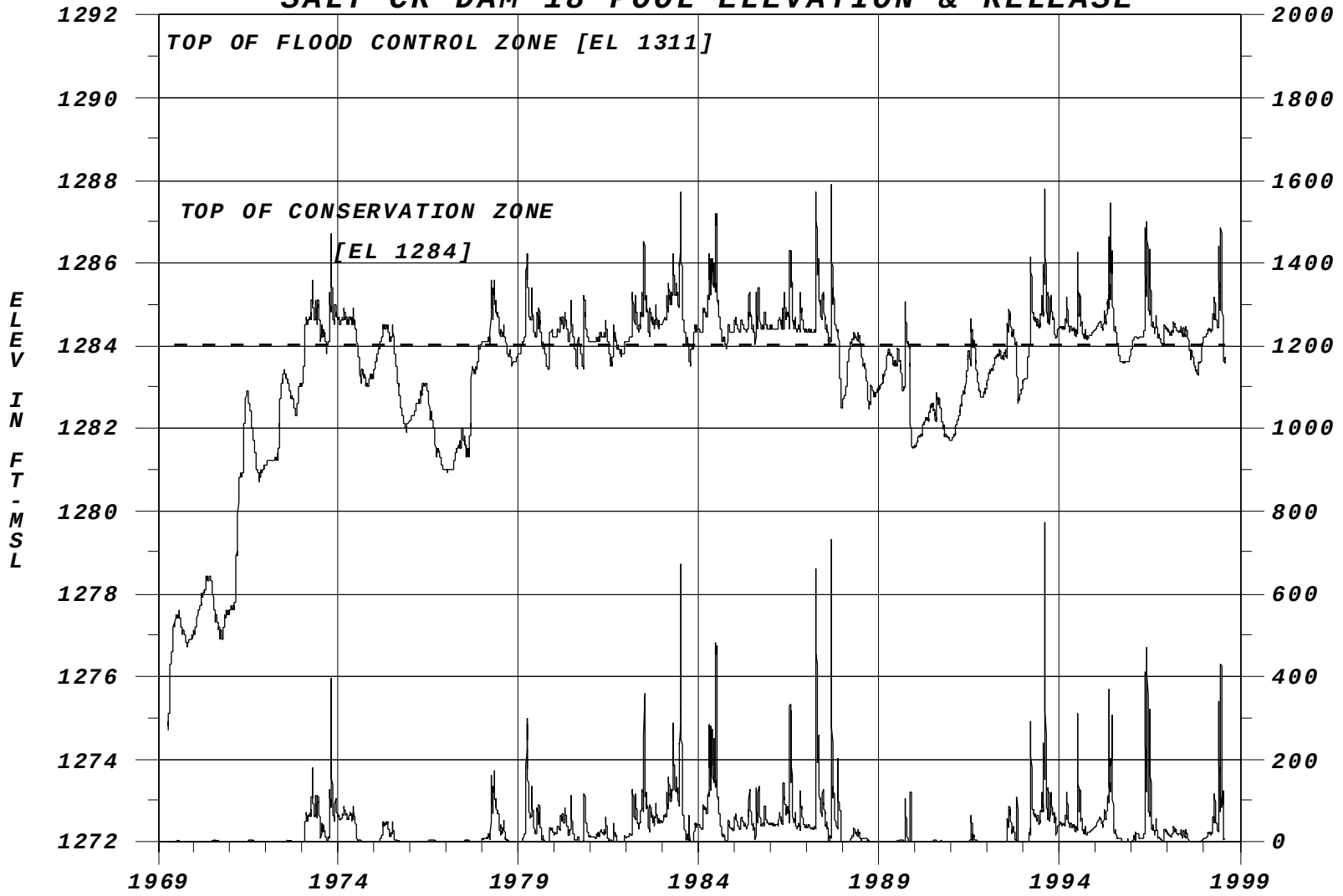


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

SALT CR DAM 18 POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

SNAKE CREEK DAM AND LAKE AUDUBON
LAKE SAKAKAWEA SUBIMPOUNDMENT
MISSOURI RIVER BASIN, NORTH DAKOTA
1997-1998 REGULATION

Lake Audubon, a subimpoundment of Garrison Reservoir, is located 8 miles northeast of Riverdale, North Dakota. The embankment, known as "Snake Creek", has a crest elevation of 1865.0 ft-msl. The original planned operating level of 1850.0 ft-msl, Lake Audubon would cover 20,600 acres and contains 396,000 acre-feet of water. The latest agreed on operating level of 1847.2 ft-msl would cover 19,095 acres and contains 346,419 AF of water.

The embankment was constructed with the primary purpose of relocating U.S. Highway 83 and the Soo Line Railroad across the Snake Creek Arm of the Garrison Diversion. In addition, during the planning stage it was decided to create a gated subimpoundment for the dual purpose of fish and wildlife enhancement, and the future diversion of water for anticipated irrigation. The pool level has been kept below elevation 1850.0 ft-msl because (1) all land surrounding the lake has not been acquired to maintain the 1850.0 ft-msl level and (2) that level (head) is not needed to supply water to the revised lower irrigation acreage. Garrison pool levels are limited to less than 15 feet above the Audubon pool for dam safety consideration. Most of the time, however, the Lake Audubon level is higher than the Garrison pool. If the latter condition exists, the Snake Creek pumping plant, operated by the Bureau, is used to transfer water from the Garrison Reservoir to Lake Audubon. Gravity flow discharge to or from Lake Audubon is conveyed by a gated conduit 7 feet wide by 10 feet high with invert elevation at 1810.0 ft-msl. This gated conduit is normally closed.

Lake Audubon was operated in accordance with the 1987 Letter of Understanding between the Corps, the Bureau of Reclamation, Fish and Wildlife Service, and the North Dakota Game and Fish Department.

Maximums of Record:

	Pool Date
Highest	1848.61 Apr 26 76
2nd	1848.57 May 21 79

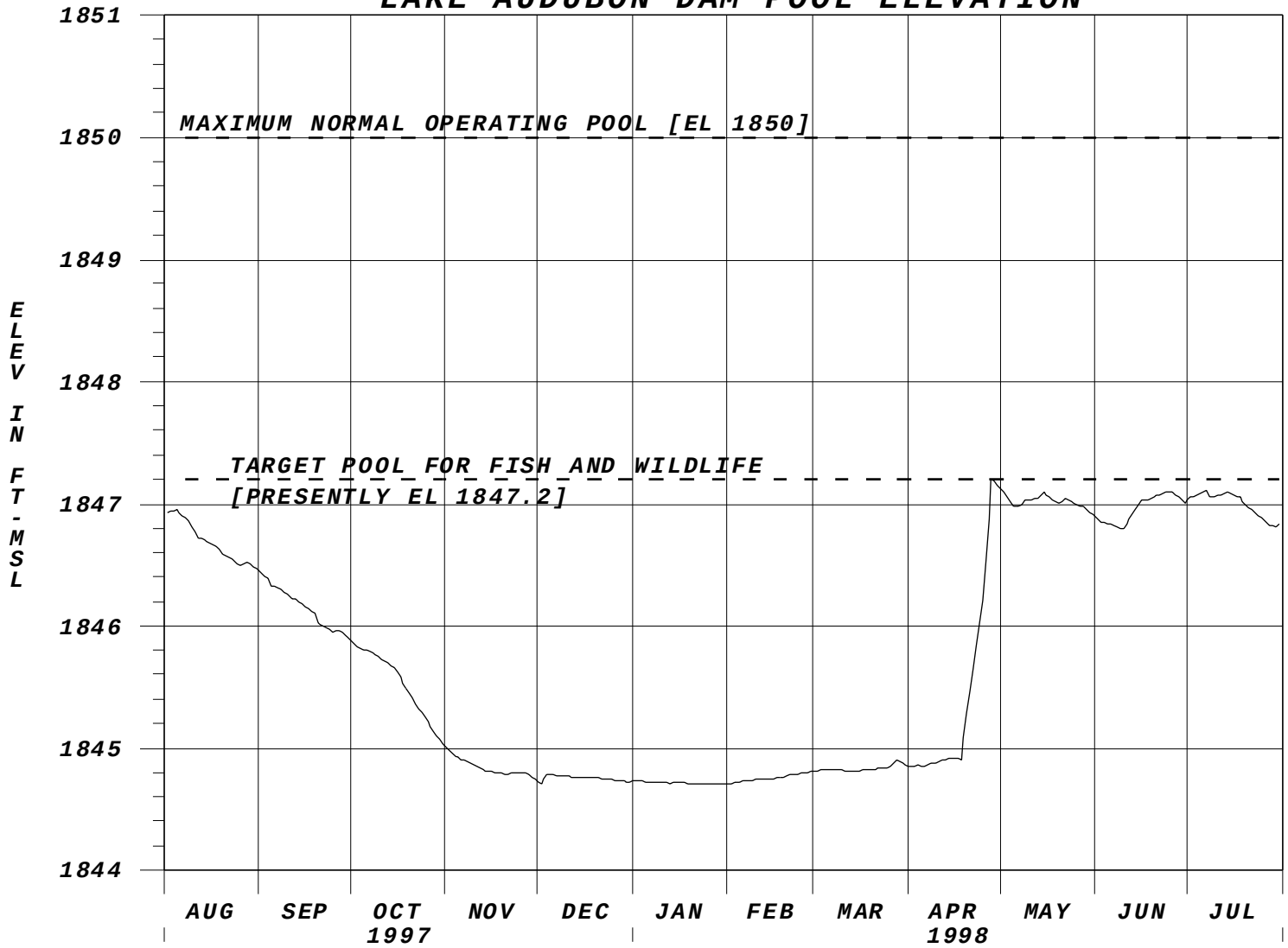
Minimums of Record (since initial fill):

	Pool Date
Lowest	1843.39 Mar 13 85
2nd	1843.50 Jan 27 92

Report Period: (August 1, 1997 through July 31, 1998)

Peak Pool Elevation (FT-MSL)	**Minimum Pool Elevation (FT-MSL)**
1847.2, Apr 27	1844.7, Dec 1

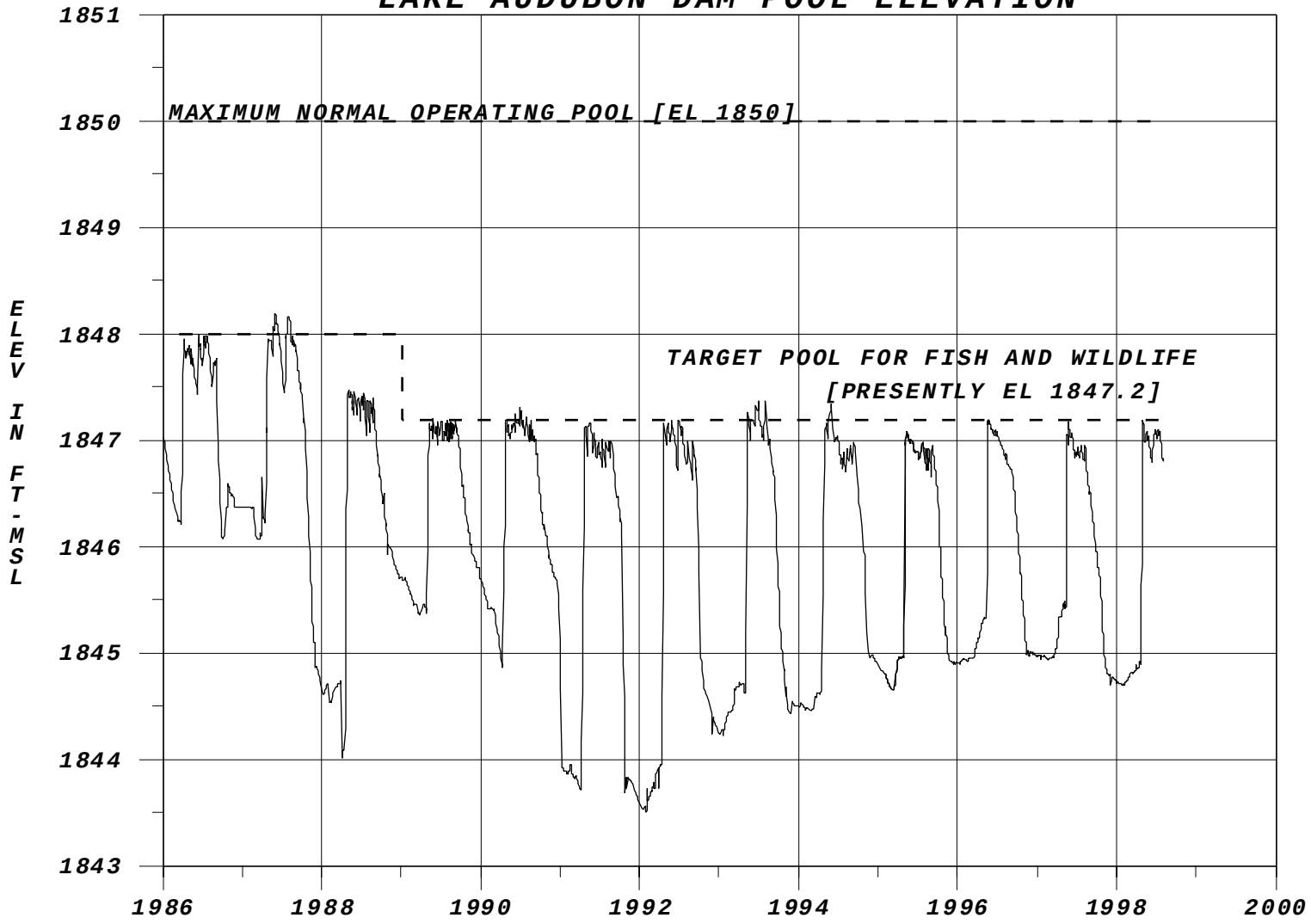
LAKE AUDUBON DAM POOL ELEVATION



Prepared By:_____

Reviewed By:_____

LAKE AUDUBON DAM POOL ELEVATION



Prepared By:_____

Reviewed By:_____

SPRING CREEK DAM AND LAKE POCASSE
(LAKE OAHE SUBIMPOUNDMENT)
MISSOURI RIVER BASIN, SOUTH DAKOTA
1997-1998 REGULATION

Lake Pocasse is operated and administered as the Pocasse National Wildlife Refuge by the Department of the Interior's Fish and Wildlife Service under an agreement with the Corps of Engineers. The pool levels of Oahe Reservoir and Lake Pocasse are contiguous at or above elevation 1617.0 ft-msl, the top of the annual flood control and multiple use zone in Lake Oahe. The long-term plan of regulation is to maintain the Lake Pocasse level as high as possible. Every 4 to 5 years, an early summer drawdown to elevation 1614.0 ft-msl will assist in the re-establishment of shoreline vegetation and improved water quality. In addition, upon evaluation of hydrologic conditions prior to the spring runoff each year above Pocasse, decisions may be made by the Section to lower the pool to accommodate the appropriate runoff volumes.

Maximums of Record:

	Pool-Date
Highest	1625.00 Mar 23 87
2nd	1624.90 Mar 31 97
3rd	1622.98 Mar 18 95

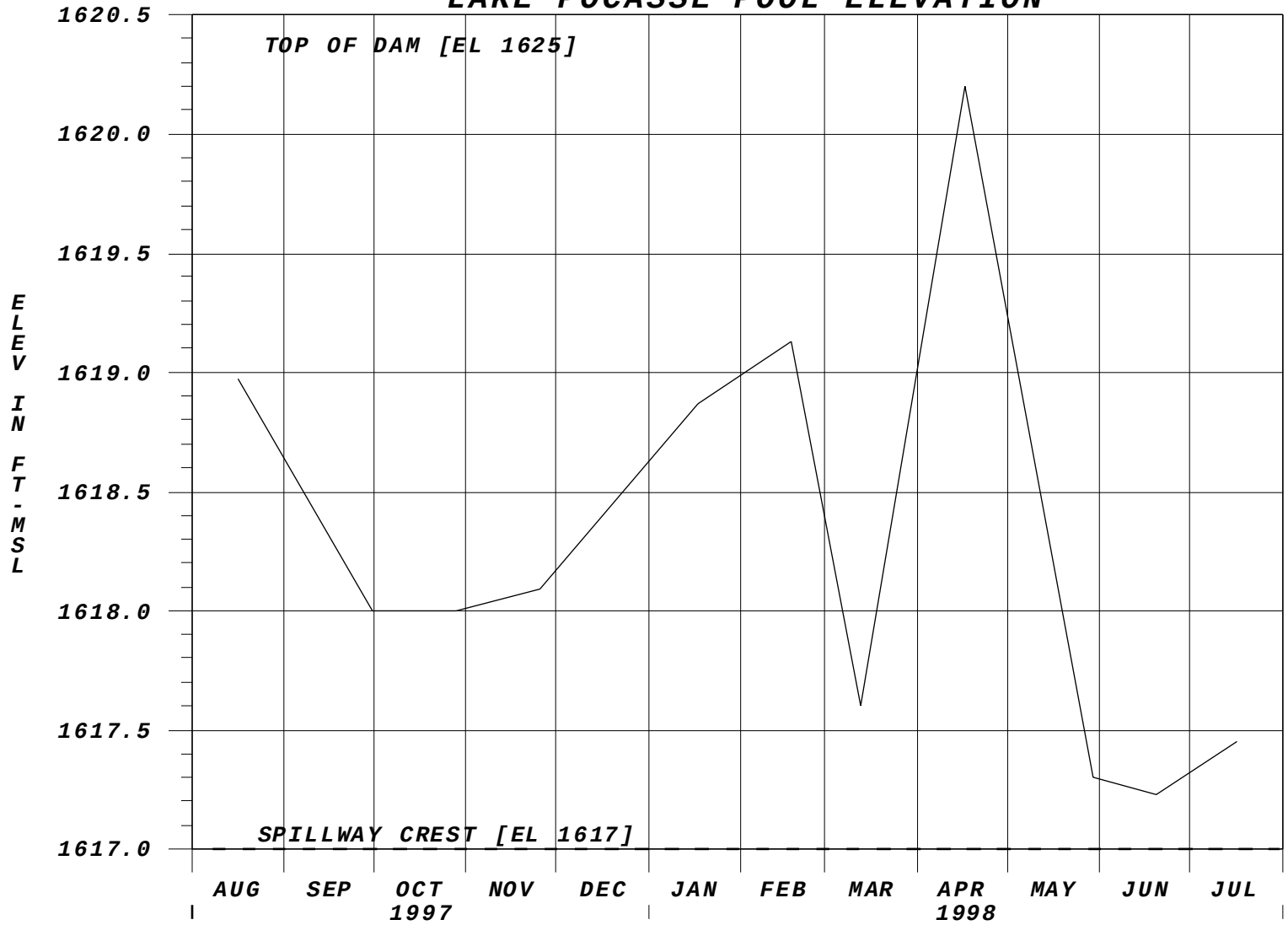
Minimums of Record (since initial fill):

	Pool-Date
Lowest	1602.69 Sep 22 90
2nd	1605.02 Oct 24 92
3rd	1606.55 Oct 29 91

Report Period: (August 1, 1997 through July 31, 1998)

Peak Pool Elevation (FT-MSL)	**Minimum Pool Elevation (FT-MSL)**
1620.2, Apr 16	1617.2, Jun 19

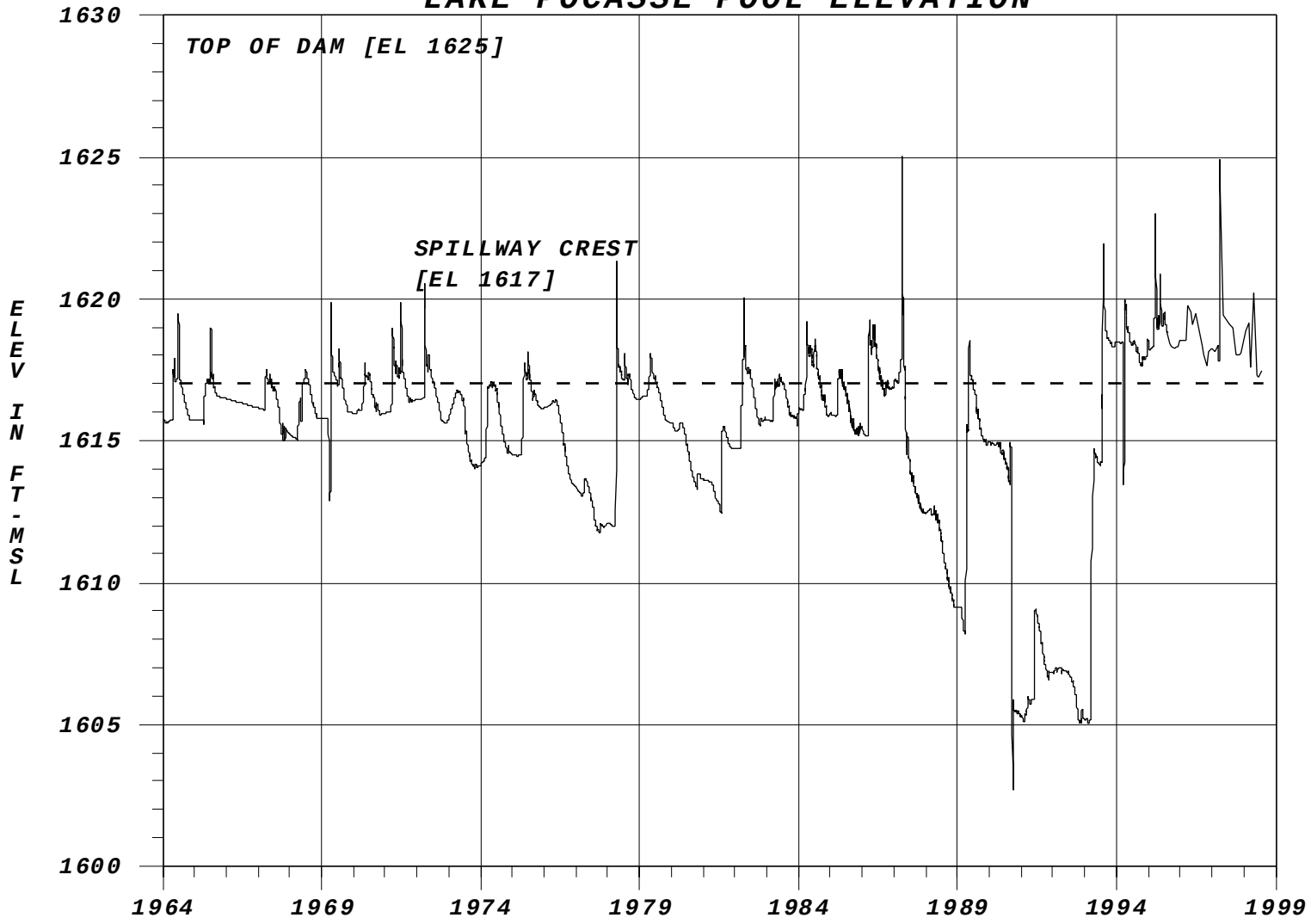
LAKE POCASSE POOL ELEVATION



Prepared By:_____

Reviewed By:_____

LAKE POCASSE POOL ELEVATION



Prepared By:_____

Reviewed By:_____

PROJECT OPERATIONS SUMMARIES

BUREAU OF RECLAMATION PROJECTS

BOYSEN DAM AND LAKE
BIGHORN RIVER BASIN, WYOMING
1997-1998 REGULATION

Boysen Reservoir is regulated by the Bureau of Reclamation (Regional Director) except when the pool level rises into the exclusive flood control zone as per the Field Working Agreement dated May 5, 1967. When this occurs release determination is the responsibility of the Corps of Engineers (District Engineer). Boysen Reservoir entered the flood control pool at 6:00 pm July 7th. Releases were maintained at 6000 cfs until the reservoir exited the flood control pool on July 16th at 5:00 pm.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	19,253 cfs Jun 23 67	14,204 cfs Jul 07 67
2nd	17,975 cfs Jun 17 63	10,688 cfs Jun 16 91
3rd	16,516 cfs Jun 15 91	9,512 cfs Jul 16 95

	Pool-Date
Highest	4730.83 Jul 06 67
2nd	4729.85 Jul 05 57
3rd	4729.18 Jun 16 91

Minimums of Record (since initial fill):

	Pool-Date
Lowest	4684.18 Mar 18-19 56
2nd	4686.42 Sep 21 60

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
1,493,070, 147% of normal

Total Outflow (AF)
1,441,036, 146% of normal

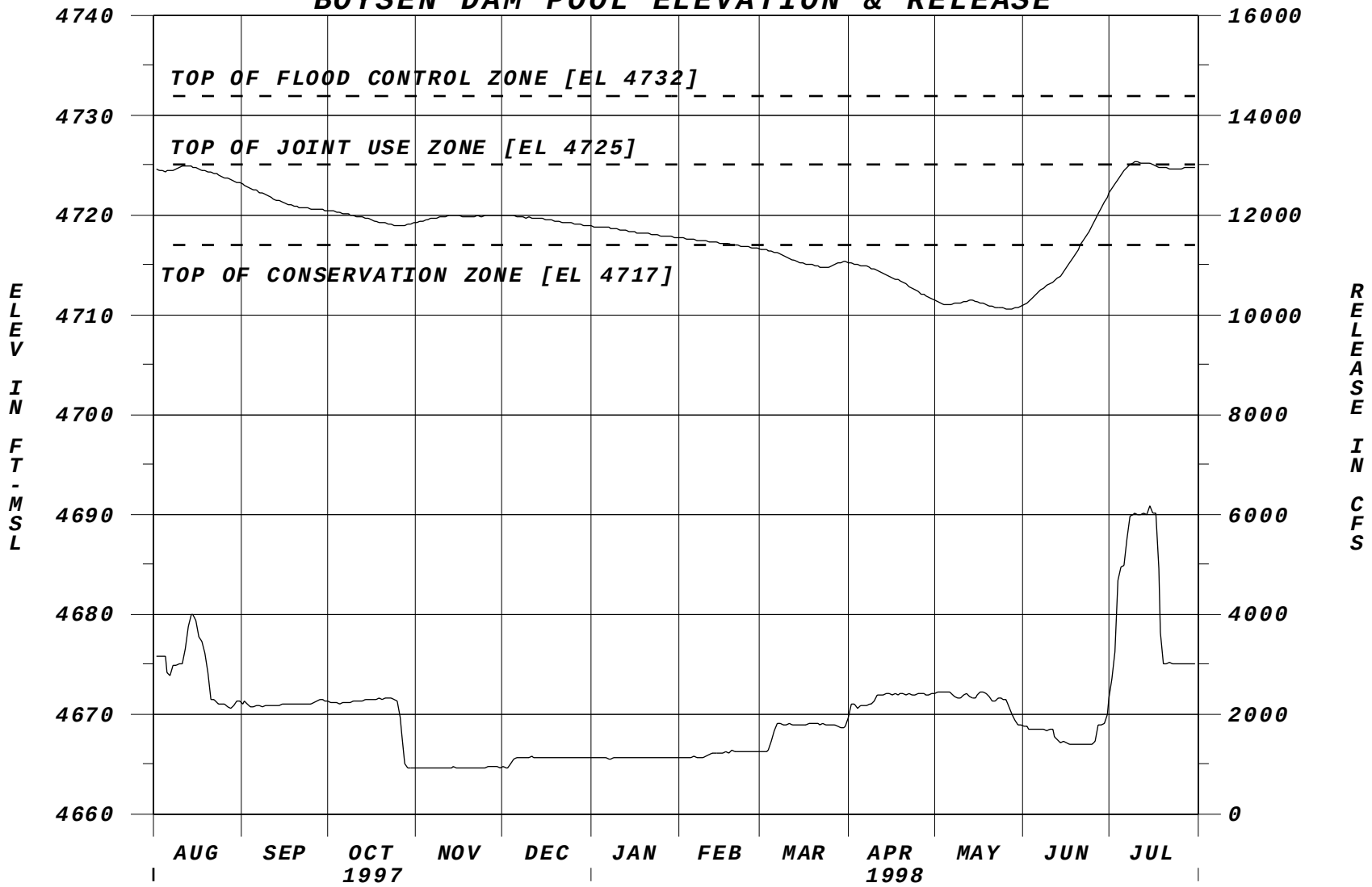
Peak Daily Inflow (CFS)
9,437, Jul 4

Peak Daily Outflow (CFS)
6,174, Jul 14

Peak Pool Elevation (FT-MSL)
4725.31, Jul 9

Minimum Pool Elevation (FT-MSL)
4710.56, May 26

BOYSEN DAM POOL ELEVATION & RELEASE

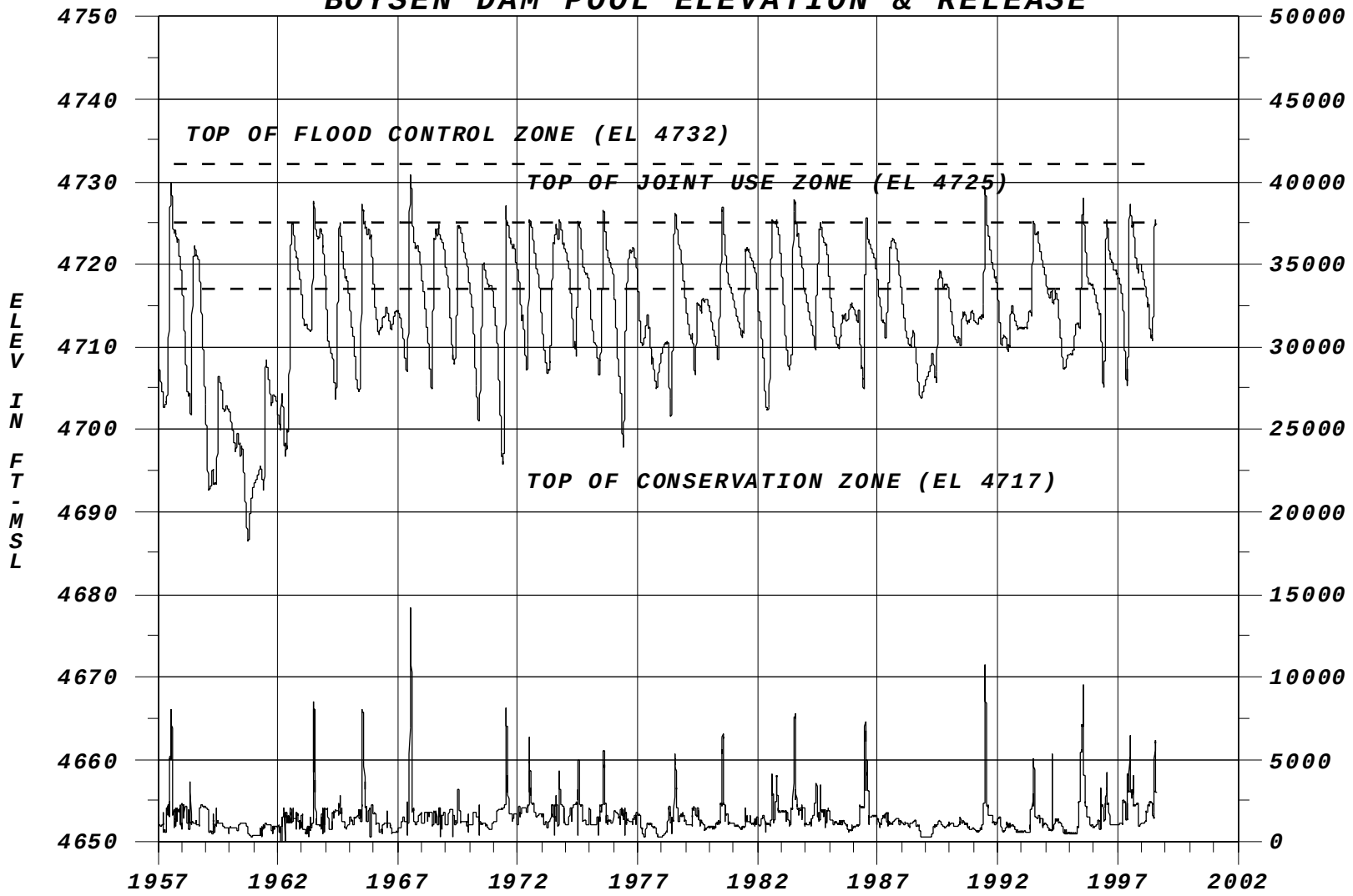


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

BOYSEN DAM POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

CANYON FERRY DAM AND RESERVOIR
MISSOURI RIVER BASIN, MONTANA
1997-1998 REGULATION

Canyon Ferry Reservoir is regulated by the Bureau of Reclamation (Regional Director) except when the pool level rises into the exclusive flood control zone or that portion of the joint use (conservation-flood control) zone required for flood control, as per the Field Working Agreement dated May 23, 1977. When this occurs, release determination is the responsibility of the Corps of Engineers (District Engineer).

The peak pool elevation of 3799.38 ft-msl on June 30, 1998 is the third highest of record since the Corps and the USBR signed a Field Working Agreement in 1966 stipulating the regulation of Canyon Ferry for flood control. It was exceeded only in 1975 and 1981 when the pool reached elevations of 3797.9 and 3799.7 ft-msl, respectively. For a description of this year's operation see "Chapter VI. Reservoir Operation".

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	35,330 cfs Jun 12 97	25,720 cfs Jun 13 81
2nd	29,050 cfs May 24 81	25,429 cfs Jun 22 97
3rd	28,752 cfs Jun 14 96	24,370 cfs Jun 19 64

	Pool-Date
Highest	3800.00 55, 56, 62, 64
2nd	3799.94 Oct 26 60
3rd	3799.93 65, 75

Minimums of Record (since initial fill):

	Pool-Date
Lowest	3764.70 Apr 11 67
2nd	3769.15 Apr 17 97

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
4,984,082, 128% of normal

Total Outflow (AF)
5,002,428, 130% of normal

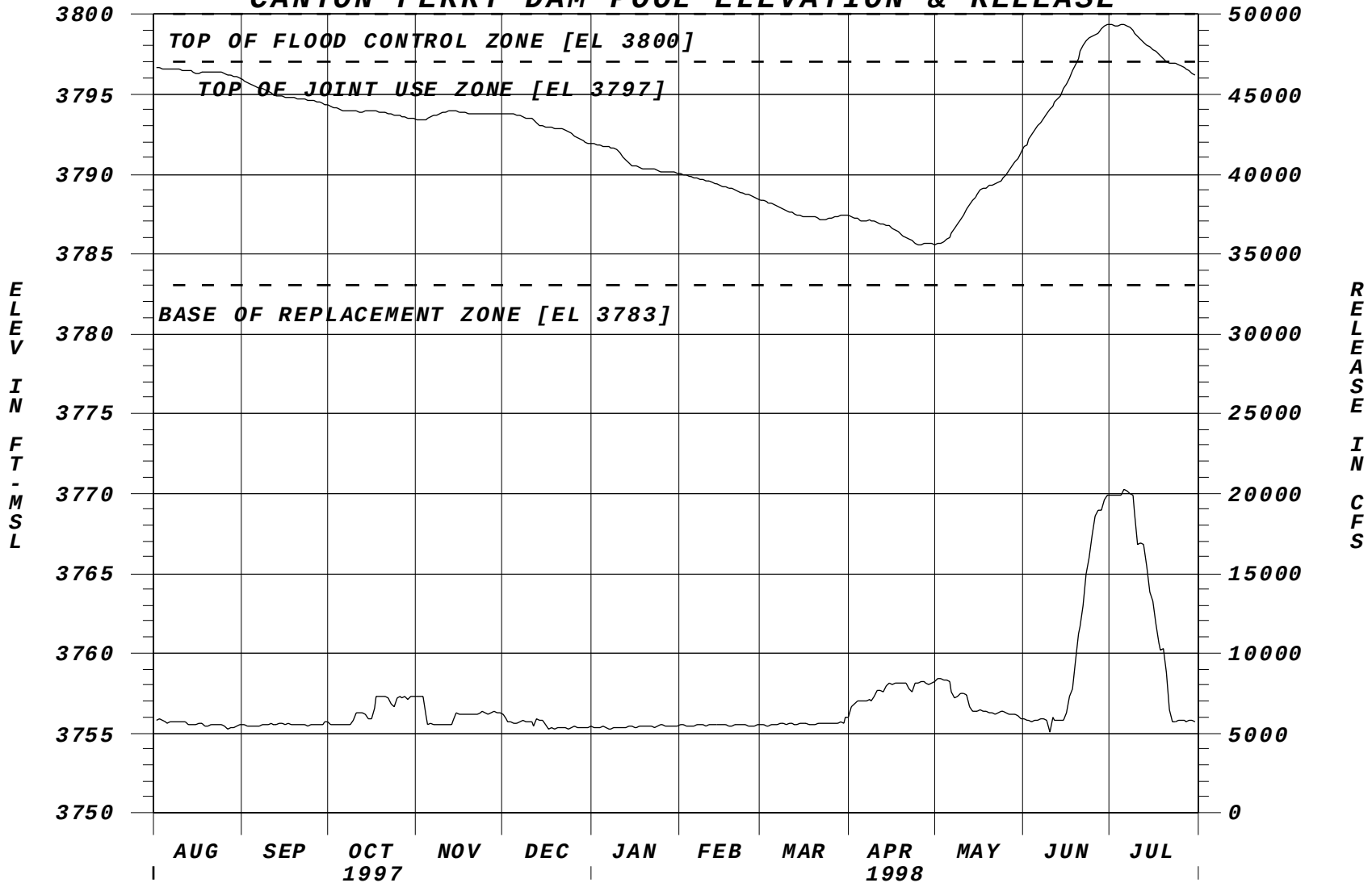
Peak Daily Inflow (CFS)
23,294, Jun 27

Peak Daily Outflow (CFS)
20,222, Jul 05

Peak Pool Elevation (FT-MSL)
3799.38, Jun 30

Minimum Pool Elevation (FT-MSL)
3785.58, Apr 24

CANYON FERRY DAM POOL ELEVATION & RELEASE

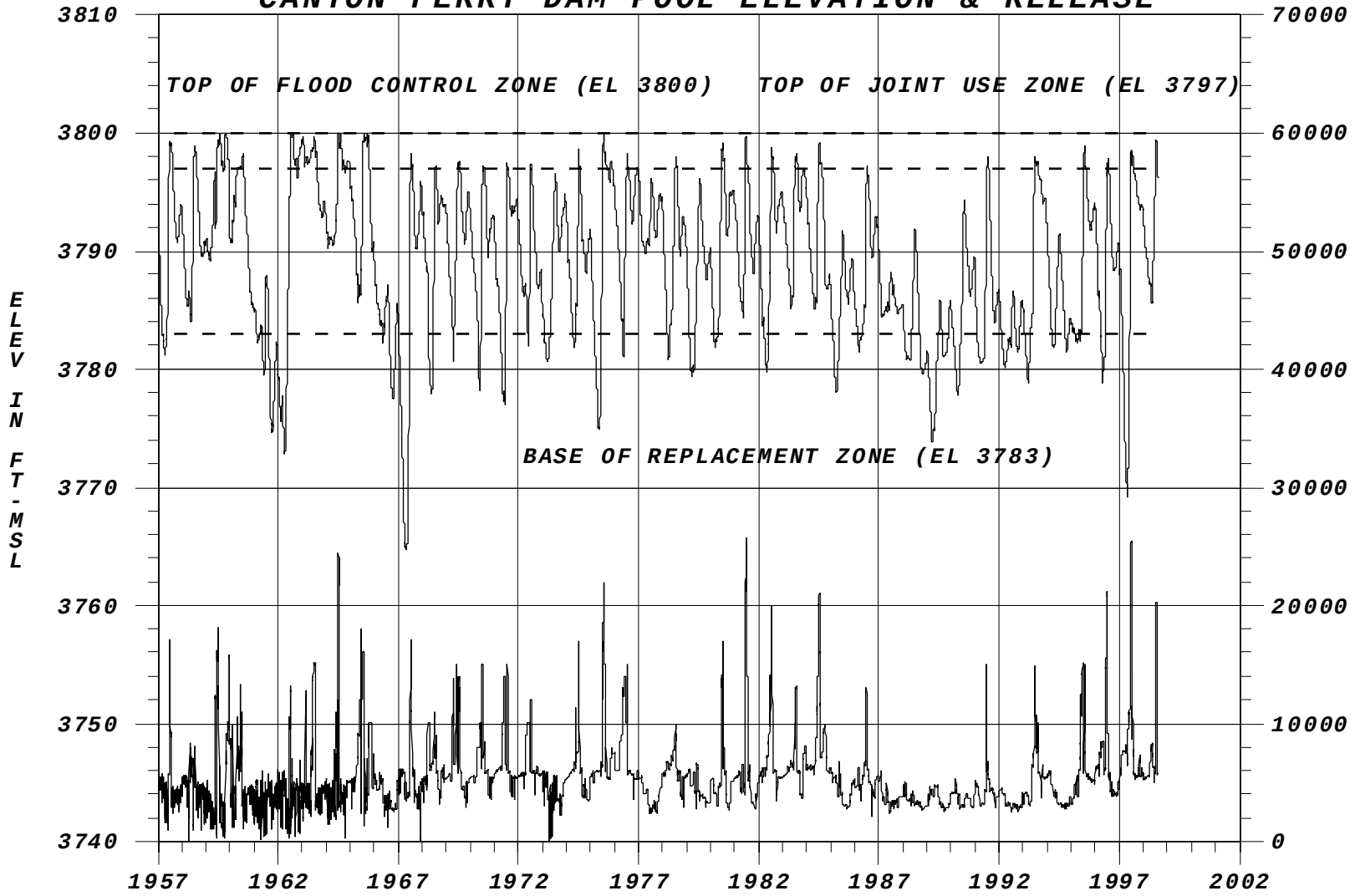


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

CANYON FERRY DAM POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

CLARK CANYON DAM AND RESERVOIR
BEAVERHEAD RIVER BASIN, MONTANA
1997-1998 REGULATION

Clark Canyon Reservoir (Hap Hawkins Lake) is regulated by the Bureau of Reclamation (Regional Director) except when the pool level rises into the exclusive flood control zone or that portion of the joint use (conservation-flood control) zone required for flood control, as per the Field Working Agreement dated November 19, 1971. When this occurs, release determination is the responsibility of the Corps of Engineers (District Engineer).

Clark Canyon Reservoir entered the flood control pool March 27th and stayed in the flood control pool for the rest of the of the reporting period. For a description of actions taken in 1998 see the write-up for Clark Canyon Reservoir under Chapter VI, Reservoir Operations, in the main body of the report.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	3,416 cfs Jun 22 84	2,586 cfs Jun 25 84
2nd	2,800 cfs Jun 20 75	1,538 cfs Jul 26 95
3rd	2,563 cfs Jun 06 95	1,289 cfs Jul 30 75

	Pool-Date
Highest	5564.70 Jun 25 84
2nd	5556.88 Jul 22 75
3rd	5554.54 Jun 25 76

Minimums of Record (since initial fill):

	Pool-Date
Lowest	5508.67 Aug 23-25 89
2nd	5509.83 Sep 24 92

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
394,140,137% of normal

Total Outflow (AF)
367,210, 129% of normal

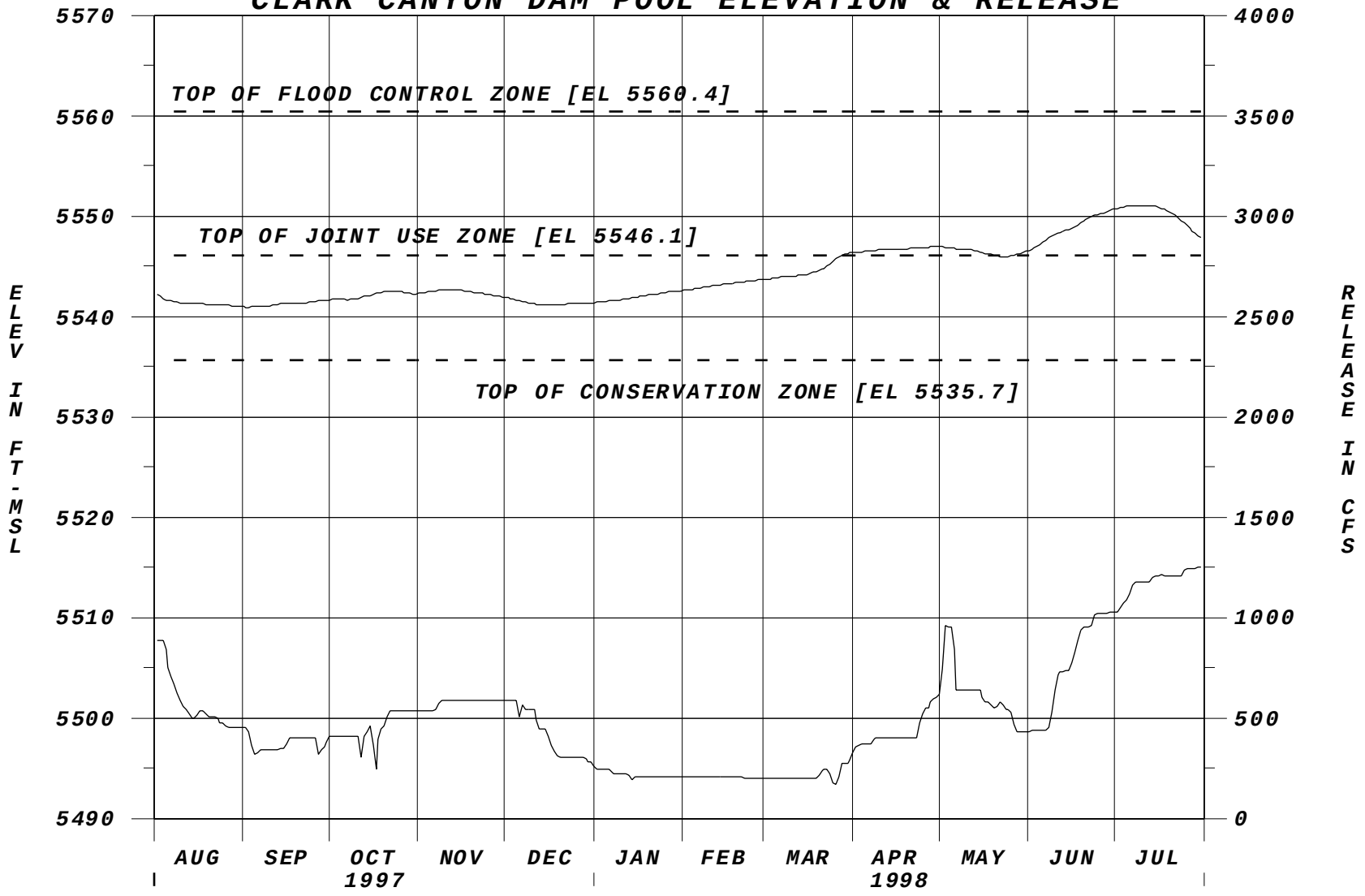
Peak Daily Inflow (CFS)
1,531, Jun 18

Peak Daily Outflow (CFS)
1,257, Jul 29

Peak Pool Elevation (FT-MSL)
5551.08, Jul 09

Minimum Pool Elevation (FT-MSL)
5540.93, Sep 02

CLARK CANYON DAM POOL ELEVATION & RELEASE

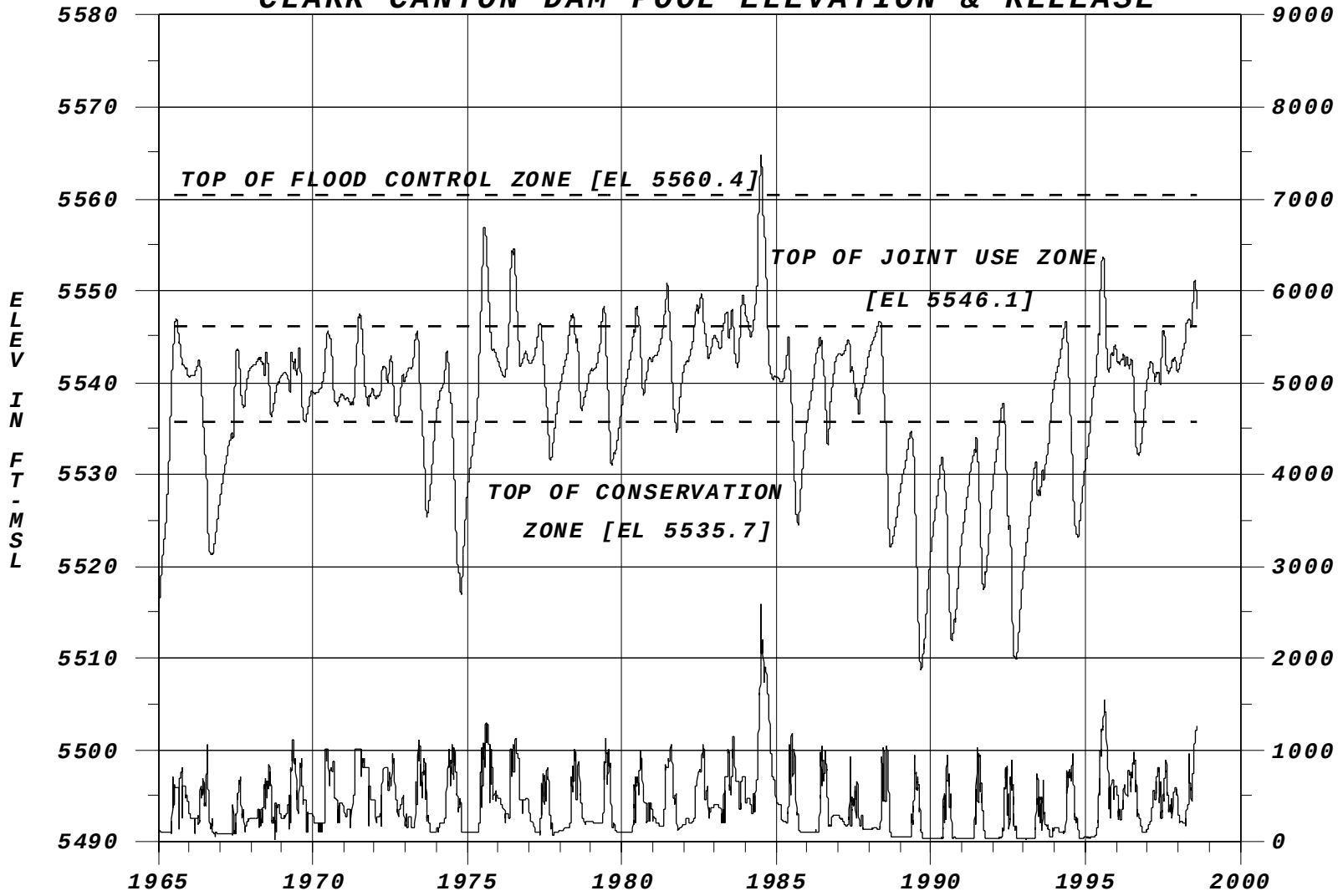


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

CLARK CANYON DAM POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

GLENDO DAM AND RESERVOIR
NORTH PLATTE RIVER BASIN, WYOMING
1997-1998 REGULATION

Glendo Reservoir is regulated by the Bureau of Reclamation (Regional Director) except when the pool level rises into the exclusive flood control zone. When this occurs, release determination is the responsibility of the Corps of Engineers (District Engineer) as per the Field Working Agreement dated May 12, 1977. Glendo Reservoir experienced no flood control activities during the reporting period.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	18,840 cfs May 15 65	10,292 cfs Jun 30 84
2nd	17,560 cfs Jun 13 70	10,266 cfs Jul 01 84
3rd	14,661 cfs May 21 73	10,060 cfs Aug 26 83

	Pool-Date
Highest	4650.90 May 27 73
2nd	4650.27 Jun 14 83
3rd	4648.45 May 31 71

Minimums of Record (since initial fill):

	Pool-Date
Lowest	4548.10 Sep 28 66
2nd	4560.42 Sep 26 72

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
1,145,210, 98% of normal

Total Outflow (AF)
1,303,712, 115% of normal

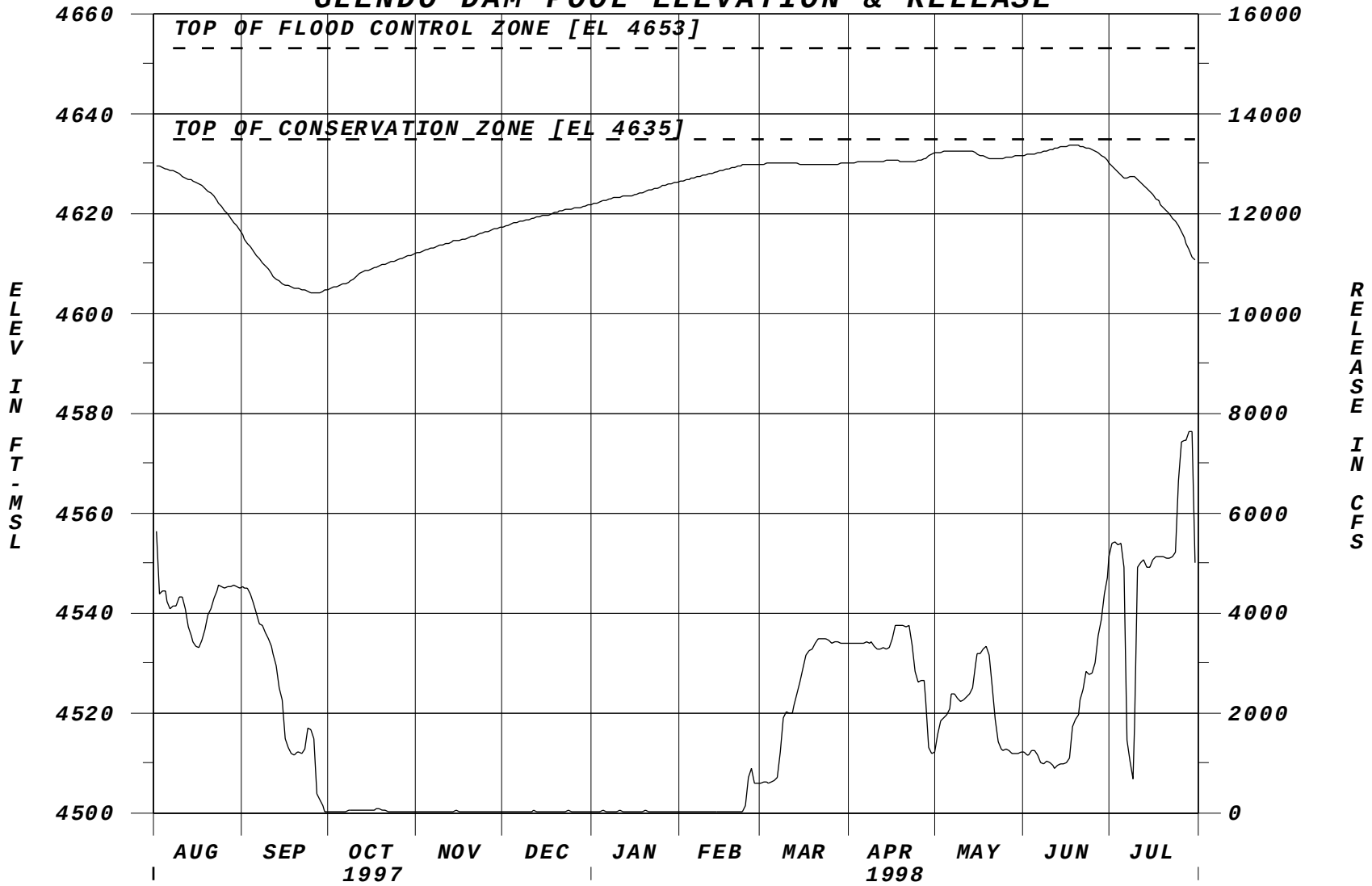
Peak Daily Inflow (CFS)
4,040, Mar 27

Peak Daily Outflow (CFS)
7,646, Jul 28

Peak Pool Elevation (FT-MSL)
4633.64, Jun 16

Minimum Pool Elevation (FT-MSL)
4604.04 Sep 25

GLENDO DAM POOL ELEVATION & RELEASE

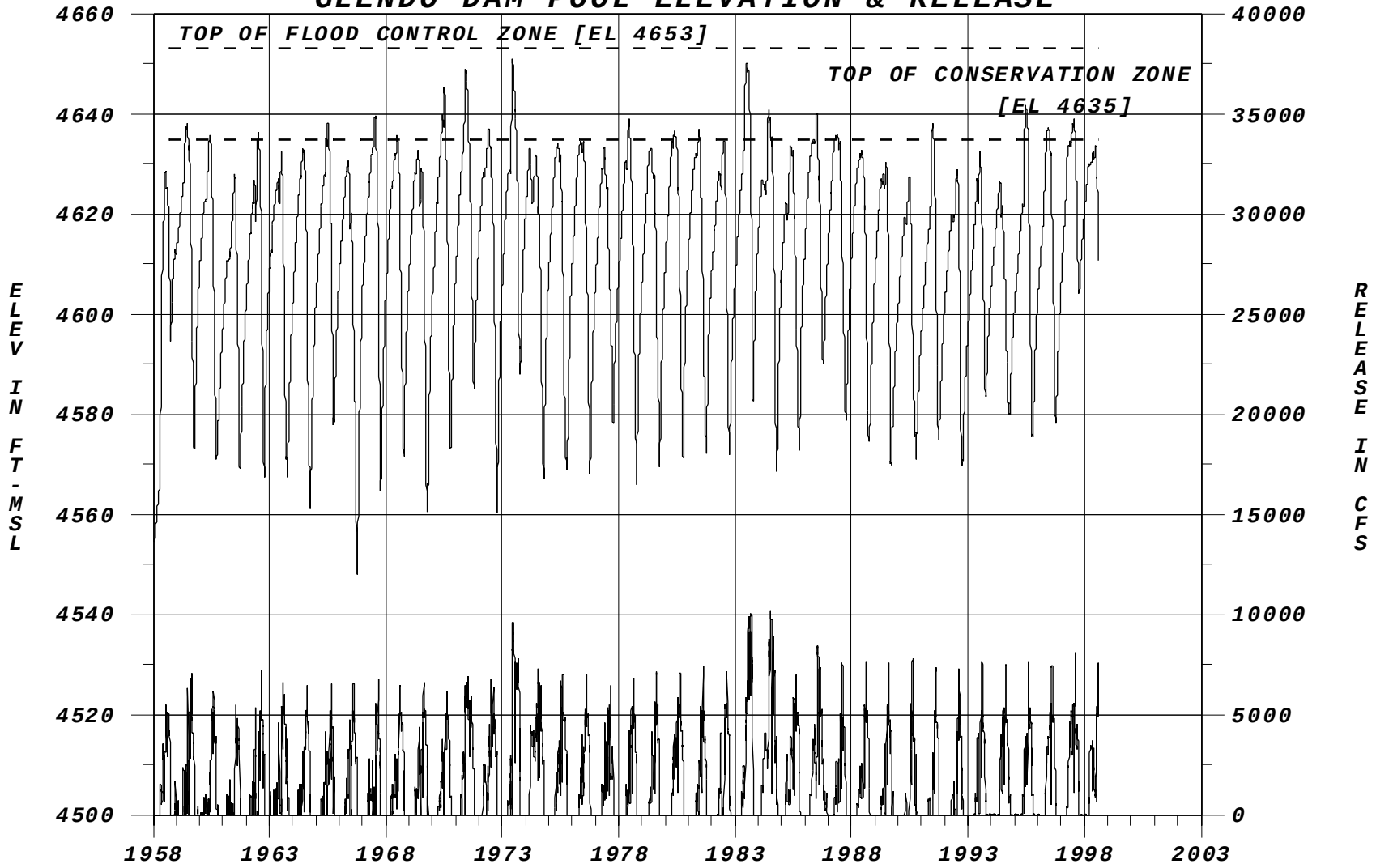


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

GLENDO DAM POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

HEART BUTTE DAM AND RESERVOIR (LAKE TSCHIDA)
HEART RIVER BASIN, NORTH DAKOTA
1997-1998 REGULATION

Heart Butte Reservoir is regulated by the Bureau of Reclamation (Regional Director) except when the pool level rises into the exclusive flood control zone. When this occurs, release determination is the responsibility of the Corps of Engineers (District Engineer) as per the Field Working Agreement dated March 15, 1951.

With only minor encroachment into the flood control zone, no significant discharges were made through the ungated morning glory spillway. The capacity of the spillway at the top of the flood control pool is 4,450 cfs. This discharge is well within the downstream channel capacity.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	22,090 cfs May 09 70	4,100 cfs Apr 09 52
2nd	21,660 cfs Apr 17 50	3,932 cfs Apr 01 78
3rd	15,114 cfs Jun 14 97	3,864 cfs May 13 70

	Pool-Date
Highest	2086.23 Apr 09 52
2nd	2083.77 Mar 31 78
3rd	2082.70 May 12 70

Minimums of Record (since initial fill):

	Pool-Date
Lowest	2049.04 Oct 31 91
2nd	2049.22 Oct 31 92
3rd	2051.44 Nov 07 90

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
37,167, 42% of normal

Total Outflow (AF)
43,592, 50% of normal

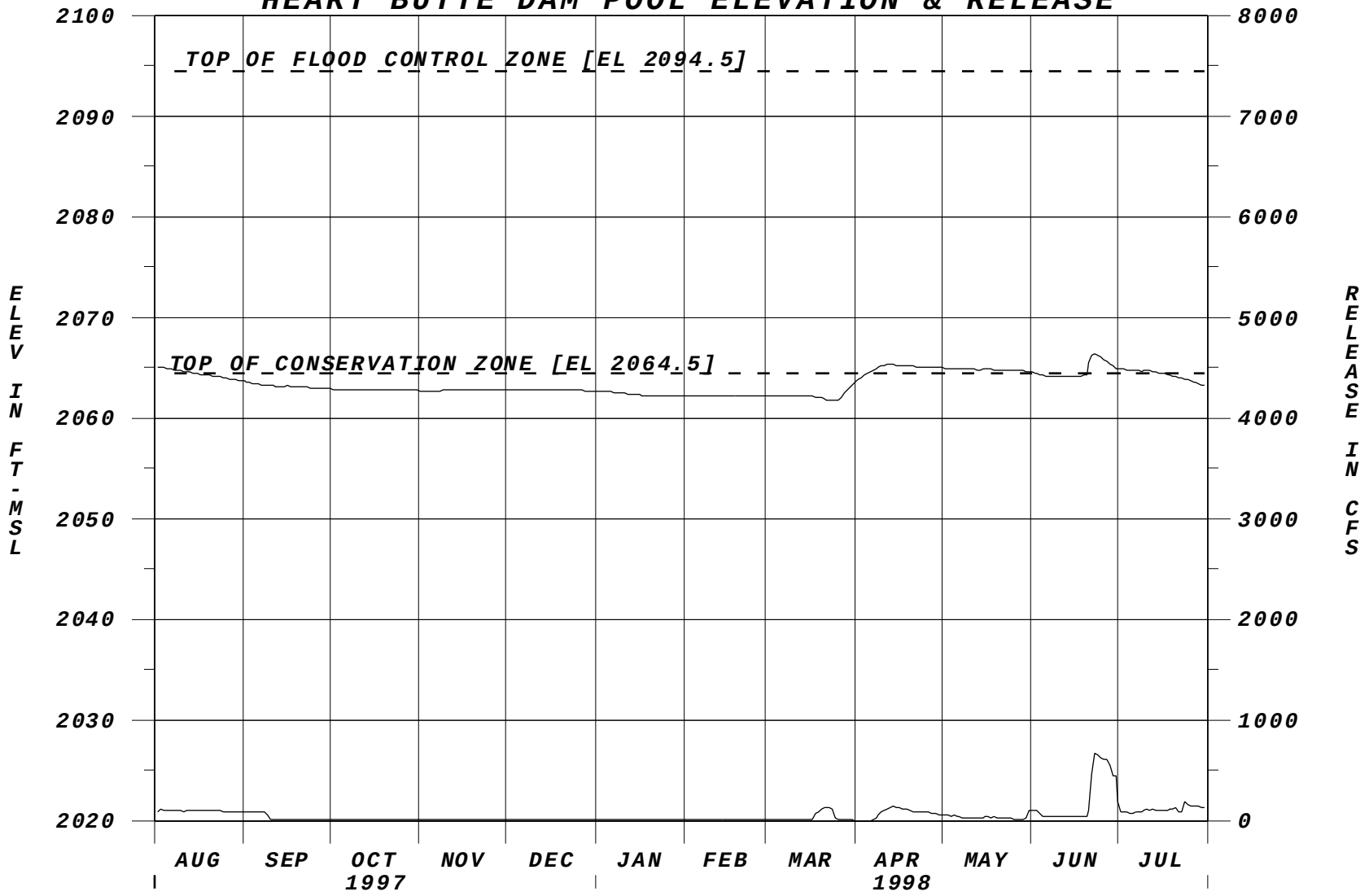
Peak Daily Inflow (CFS)
1,950, Jun 20

Peak Daily Outflow (CFS)
665, Jun 22

Peak Pool Elevation (FT-MSL)
2066.37, Jun 22

Minimum Pool Elevation (FT-MSL)
2061.76, Mar 23

HEART BUTTE DAM POOL ELEVATION & RELEASE

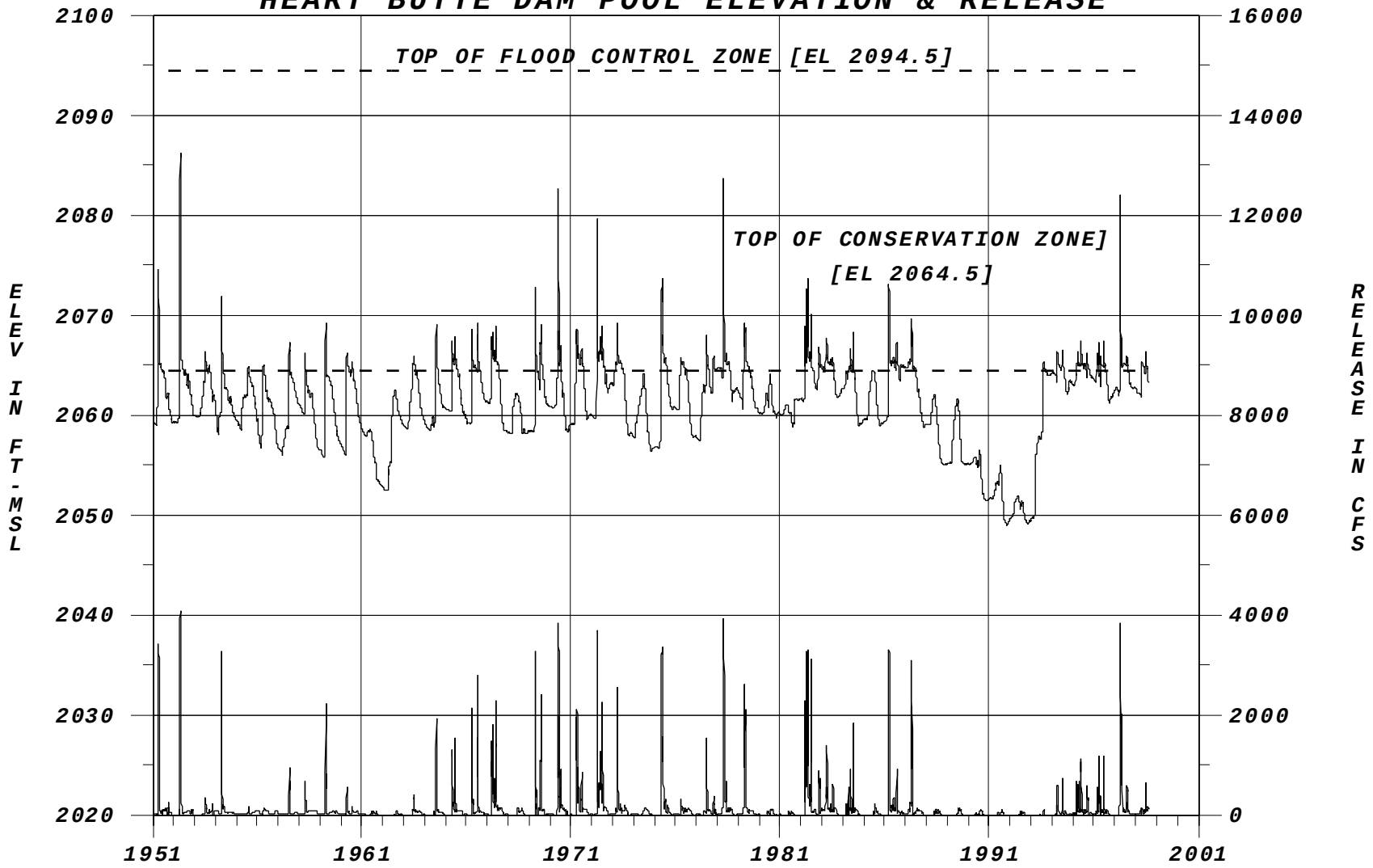


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

HEART BUTTE DAM POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

JAMESTOWN DAM AND RESERVOIR
JAMES RIVER BASIN, NORTH DAKOTA
1997-1998 REGULATION

Jamestown Reservoir is regulated by the Bureau of Reclamation (Regional Director) except when the pool level rises into the exclusive flood control zone or that portion of joint use conservation-flood control zone required for flood control, as per the Field Working Agreement dated July 15, 1975. When this occurs, release determination is the responsibility of the Corps of Engineers (District Engineer). For a description of the flooding that took place in 1998 see the write-up for Pipestem Reservoir under Section VI, Reservoir Operations, in the main body of the report.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	7,689 cfs Apr 17 69	1,702 cfs May 02 97
2nd	5,808 cfs Apr 22 97	1,169 cfs May 13 96
3rd	5,029 cfs Apr 18 96	878 cfs Apr 26 95

	Pool-Date	
Highest	1445.70 May 02 97	
2nd	1444.90 Apr 25 96	
3rd	1444.10 Apr 27 69	(USBR 1443.80 May 02 69)

Minimums of Record (since initial fill):

	Pool-Date
Lowest	1420.91 Feb 27 93
2nd	1421.85 Jul 31 92
3rd	1423.53 Jul 31 91
4th	1425.58 Jul 31 90

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
75,349, 208% of normal

Total Outflow (AF)
87,700, 246% of normal

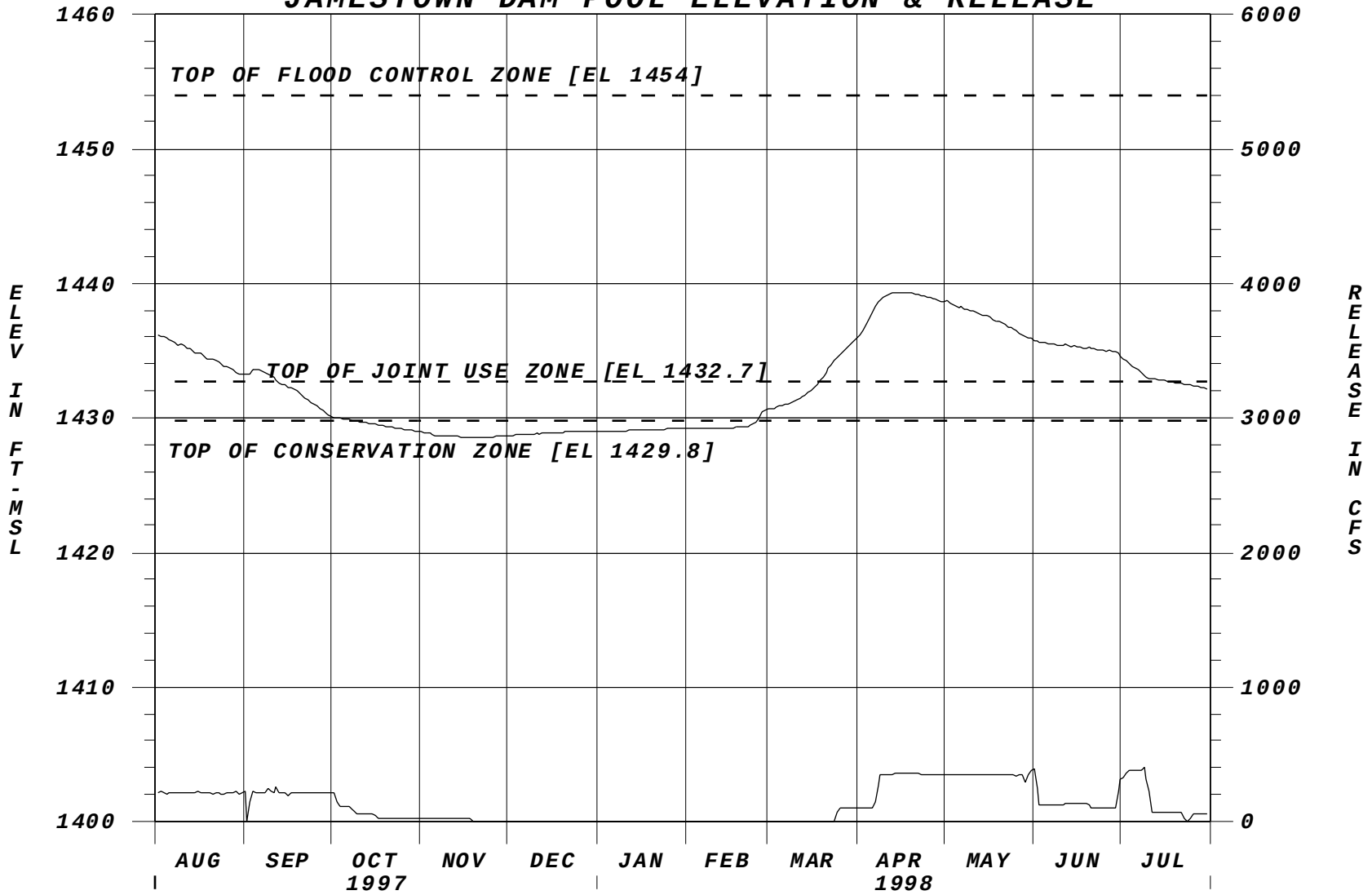
Peak Daily Inflow (CFS)
1,856, Apr 06

Peak Daily Outflow (CFS)
399, Jul 08

Peak Pool Elevation (FT-MSL)
1439.34, Apr 14

Minimum Pool Elevation (FT-MSL)
1428.50, Nov 17

JAMESTOWN DAM POOL ELEVATION & RELEASE

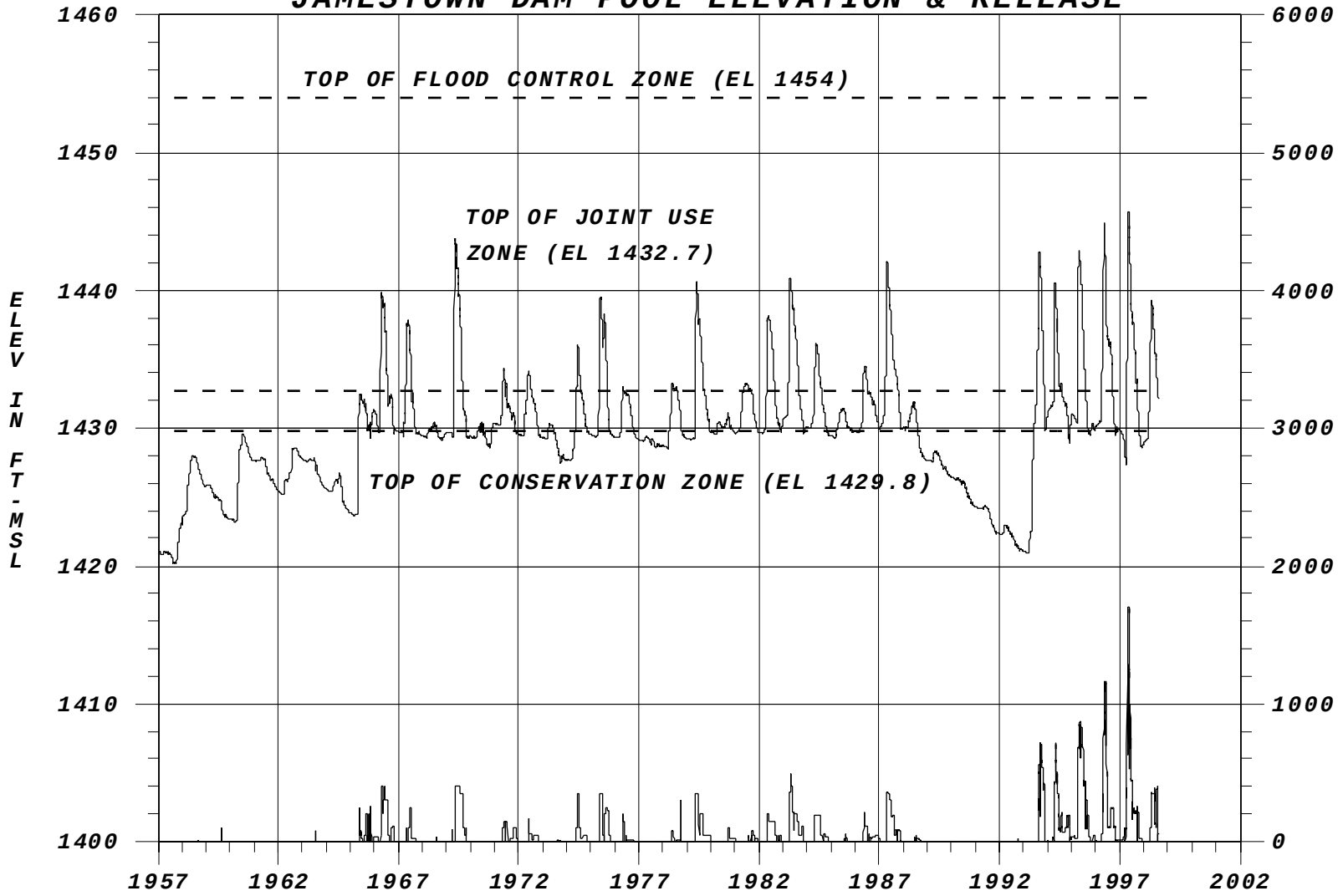


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

JAMESTOWN DAM POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

KEYHOLE DAM AND RESERVOIR
BELLE FOURCHE RIVER BASIN, WYOMING
1997-1998 REGULATION

Keyhole Reservoir is regulated by the Bureau of Reclamation (Regional Director) except when the pool level rises into the exclusive flood control zone as per the Field Working Agreement dated February 11, 1970. When this occurs, release determination is the responsibility of the Corps of Engineers (District Engineer).

The pool did not reach the flood control zone during the report period.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	10,660 cfs May 19 78	1,350 cfs May 24 78
2nd	5,200 cfs Mar 13 96	820 cfs May 23-24 62
3rd	4,780 cfs Feb 29 72	800 cfs Mar 11-15 72

	Pool-Date
Highest	4100.38 May 21 78
2nd	4098.78 Mar 07 72
3rd	4098.55 Apr 23 97

Minimums of Record (since initial fill):

	Pool-Date
Lowest	4060.32 Nov 01 92
2nd	4063.86 Jul 22-23 92
3rd	4066.94 Dec 12-22 90
4th	4070.73 Sep 18 89

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
39,733, 191% of normal

Total Outflow (AF)
5770, 39% of normal

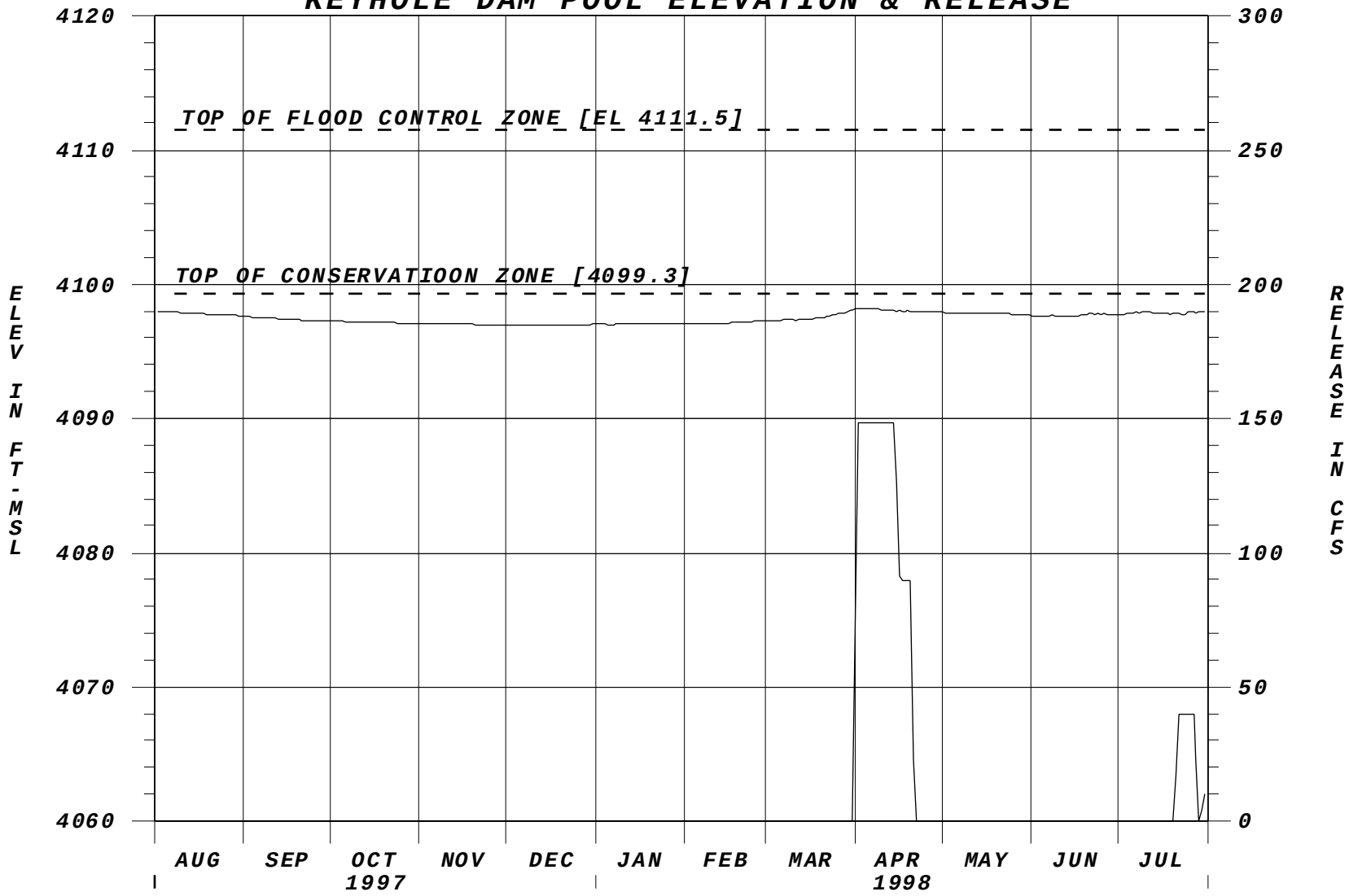
Peak Daily Inflow (CFS)
876, Jul 24

Peak Daily Outflow (CFS)
149, Apr 06

Peak Pool Elevation (FT-MSL)
4098.20 Apr 4

Minimum Pool Elevation (FT-MSL)
4096.94, Dec 11

KEYHOLE DAM POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

KEYHOLE DAM POOL ELEVATION & RELEASE

NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

PACTOLA DAM AND RESERVOIR
RAPID CREEK BASIN, SOUTH DAKOTA
1997-1998 REGULATION

Pactola Dam and Reservoir is regulated by the Bureau of Reclamation (Regional Director) except when the pool level rises into the exclusive flood control zone as per the Field Working Agreement dated August 27, 1969. When this occurs, release determination is the responsibility of the Corps of Engineers (District Engineer). Refer to Section VI for a write-up of flood control regulation for the report period.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	1,132 cfs May 16 65	500 cfs May 20 65
2nd	1,009 cfs Jun 19 98	438 cfs Jun 02 96
3rd	741 cfs May 31 96	438 cfs Jun 23 98

	Pool-Date
Highest	4585.87 May 19 65
2nd	4585.44 May 21 78
3rd	4585.35 Jun 04 96

Minimums of Record (since initial fill):

	Pool-Date
Lowest	4531.53 Jan 24 91
2nd	4533.12 Feb 21 90

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
83,299, 239% of normal

Total Outflow (AF)
82,150, 245% of normal

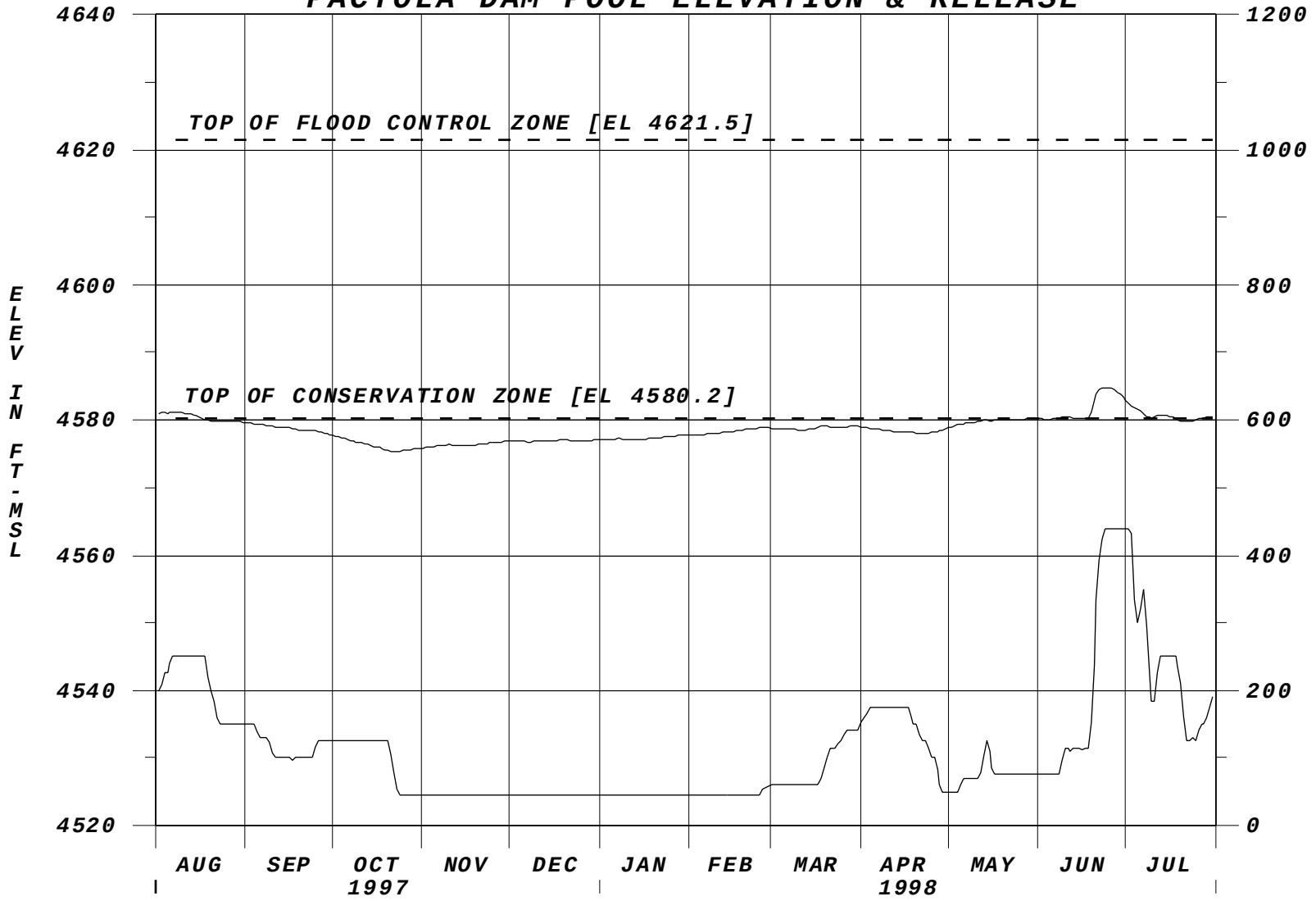
Peak Daily Inflow (CFS)
1,009, Jun 19

Peak Daily Outflow (CFS)
438, Jun 23

Peak Pool Elevation (FT-MSL)
4584.76, Jun 23

Minimum Pool Elevation (FT-MSL)
4575.31, Oct 21 97

PACTOLA DAM POOL ELEVATION & RELEASE

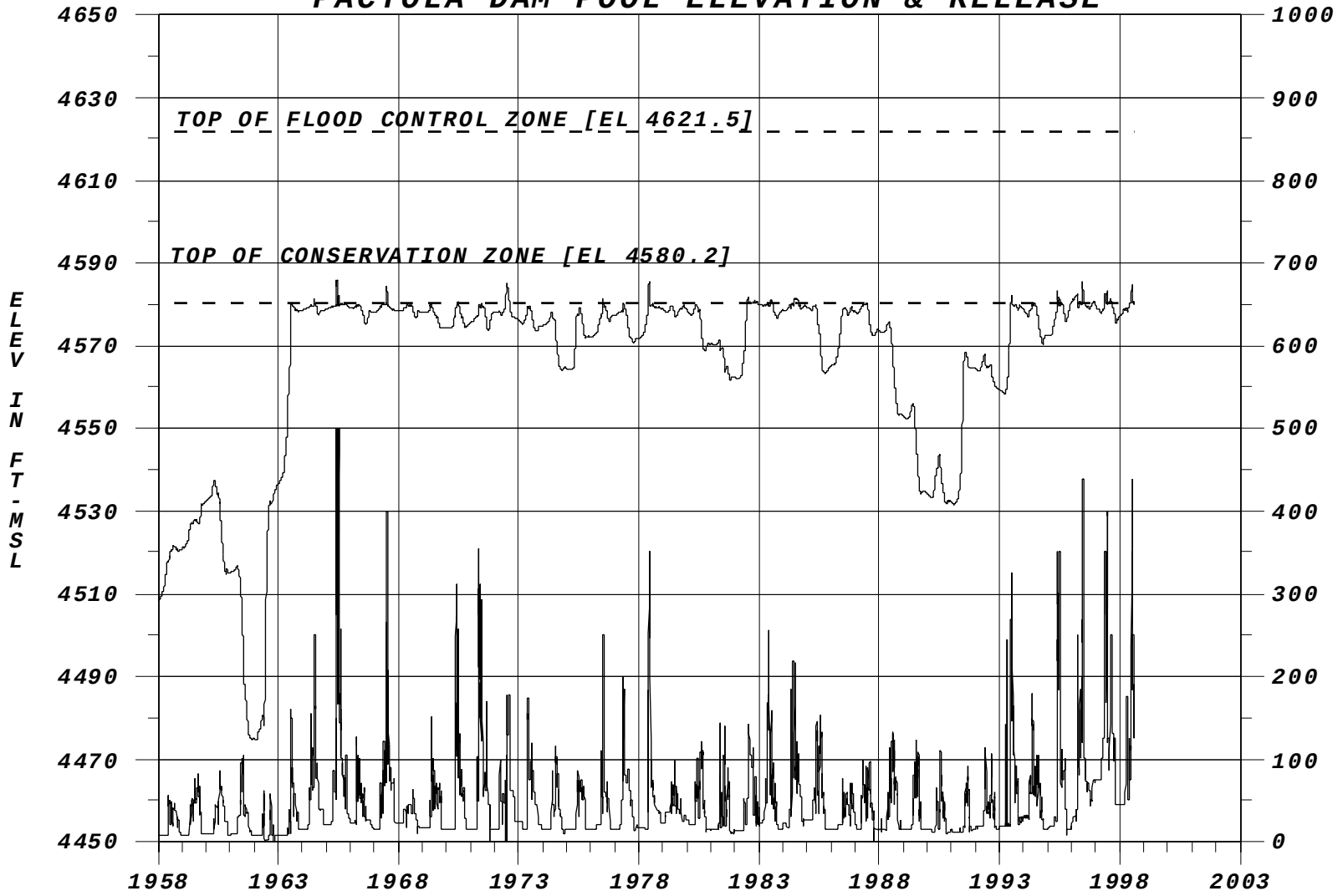


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

PACTOLA DAM POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

SHADEHILL DAM AND RESERVOIR
GRAND RIVER BASIN, SOUTH DAKOTA
1997-1998 REGULATION

Shadehill Reservoir is regulated by the Bureau of Reclamation (Regional Director) except when the pool level rises into the exclusive flood control zone as per the Field Working Agreement dated May 15, 1972. When this occurs, release determination is the responsibility of the Corps of Engineers (District Engineer). Shadehill Reservoir experienced no flood control activities during the reporting period.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	32,152 cfs Apr 08 52	5,078 cfs Apr 10 52
2nd	11,333 cfs Mar 22 97	4,120 cfs Apr 03 78
3rd	9,690 cfs Mar 30 78	4,038 cfs Mar 24 97

	Pool-Date
Highest	2297.90 Apr 10 52
2nd	2282.42 Apr 02 78
3rd	2280.01 Mar 24 97

Minimums of Record (since initial fill):

	Pool-Date
Lowest	2258.62 Nov 17 81
2nd	2259.11 Feb 28 62

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
42,344, 65% of normal

Total Outflow (AF)
43,560, 65% of normal

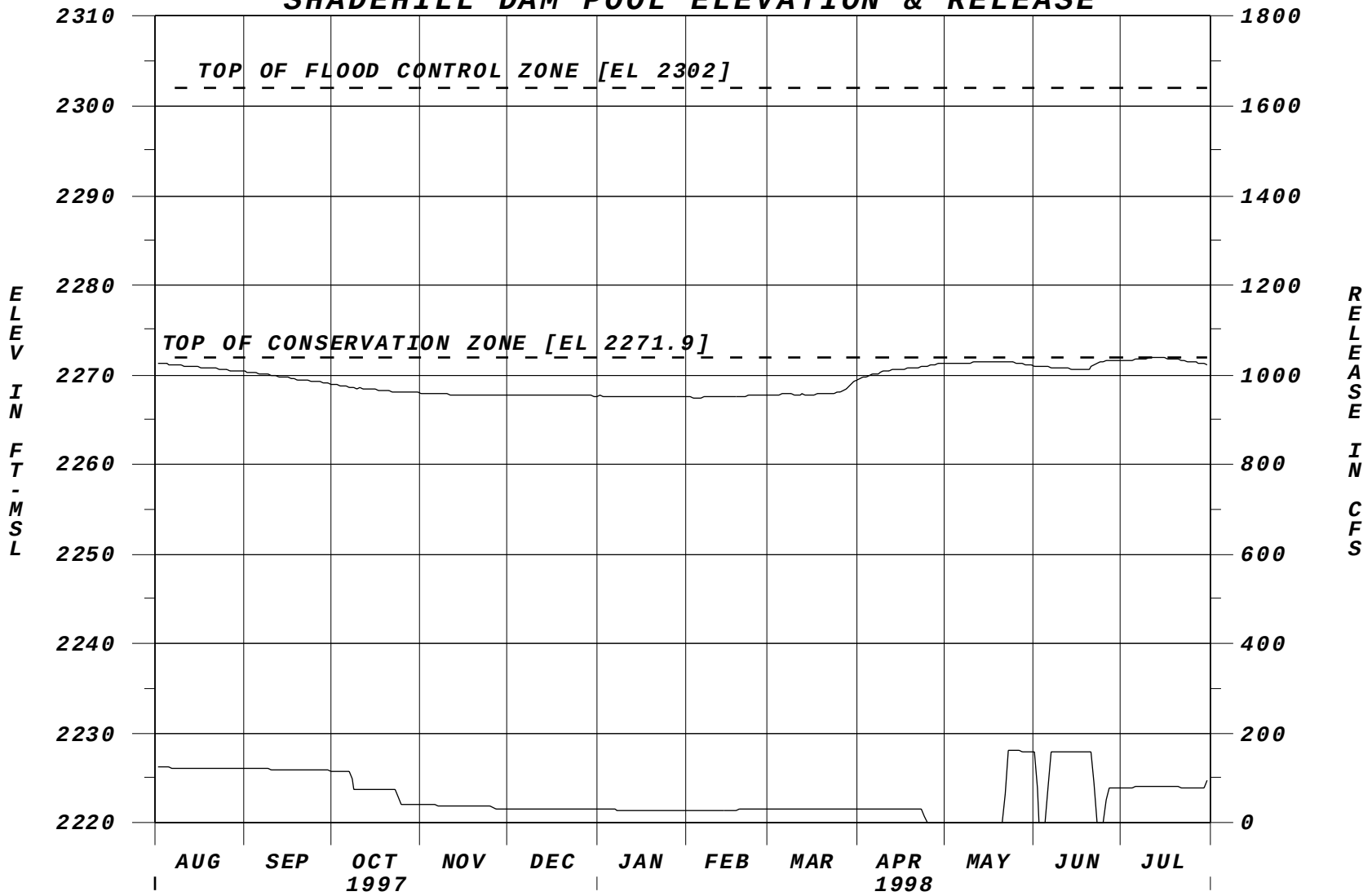
Peak Daily Inflow (CFS)
1,036, Jun 20

Peak Daily Outflow (CFS)
160, May 22

Peak Pool Elevation (FT-MSL)
22.71.95, Jul 11

Minimum Pool Elevation (FT-MSL)
2267.43, Feb 02

SHADEHILL DAM POOL ELEVATION & RELEASE

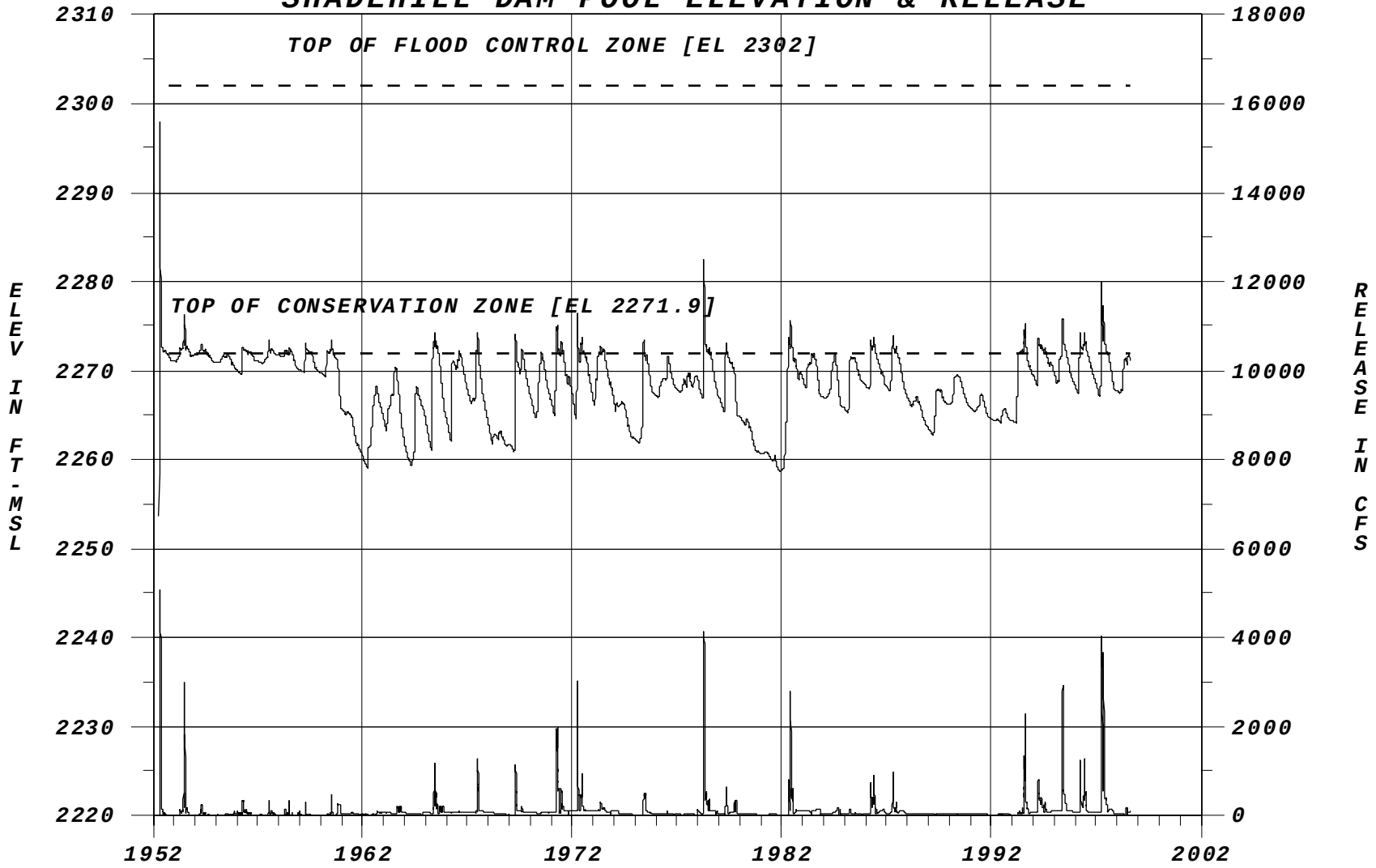


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

SHADEHILL DAM POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

TIBER DAM AND RESERVOIR (LAKE ELWELL)
MARIAS RIVER BASIN, MONTANA
1997-1998 REGULATION

Tiber Reservoir is regulated by the Bureau of Reclamation except when the pool level rises into the flood control zone or that portion of the joint use (conservation-flood control) zone required for flood control as per the Water Control Agreement. When this occurs, release determination is the responsibility of the Corps of Engineers (District Engineer). When replacement storage is required for the downstream Fort Peck Reservoir, releases from Tiber Dam will be adjusted beginning March 1, based on anticipated inflow, to fill the flood control storage zone to elevation 3008.1 ft-msl prior to mid-July. Minimum releases to achieve this fill are 300 cfs. No flood control operation occurred during the report period.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	102,888 cfs Jun 10 64	10,300 cfs Jun 13-14 64
2nd	52,981 cfs Jun 21 75	5,777 cfs Jun 25 75; Jul 11 75
3rd	26,391 cfs Feb 26 86	5,308 cfs Jun 22-24 67

	Pool-Date
Highest	3005.59 Jul 12 65
2nd	3001.91 Jun 13 64
3rd	2996.50 Jul 08 97

Minimums of Record (since initial fill):

	Pool-Date
Lowest	2953.81 Mar 28 68
2nd	2955.31 Apr 27 67

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
451,993, 71% of normal

Total Outflow (AF)
533,090, 87% of normal

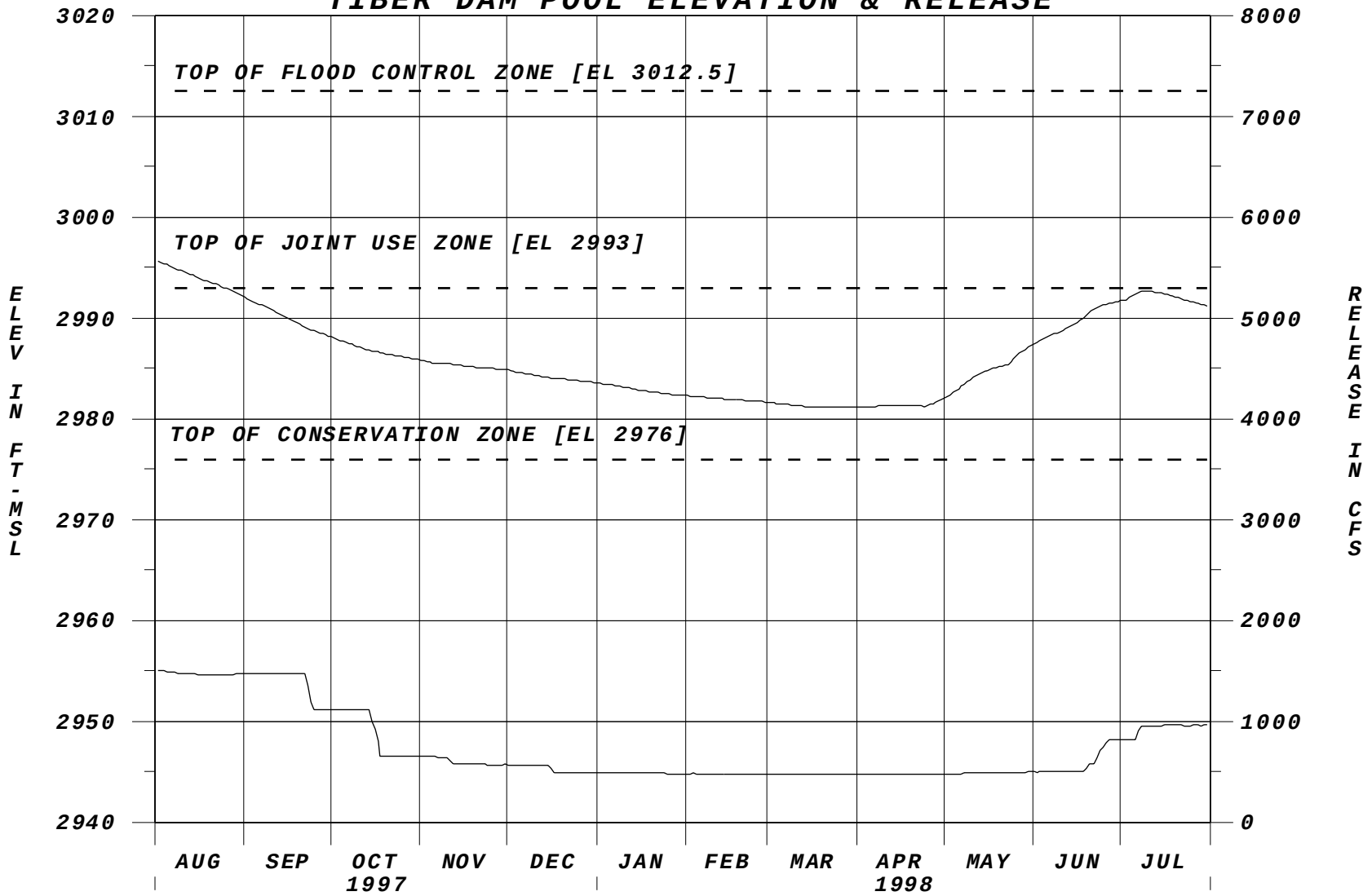
Peak Daily Inflow (CFS)
3,413, Jul 04

Peak Daily Outflow (CFS)
1,511, Aug 01

Peak Pool Elevation (FT-MSL)
2,995.63, Aug 01

Minimum Pool Elevation (FT-MSL)
2981.19, Mar 16

TIBER DAM POOL ELEVATION & RELEASE

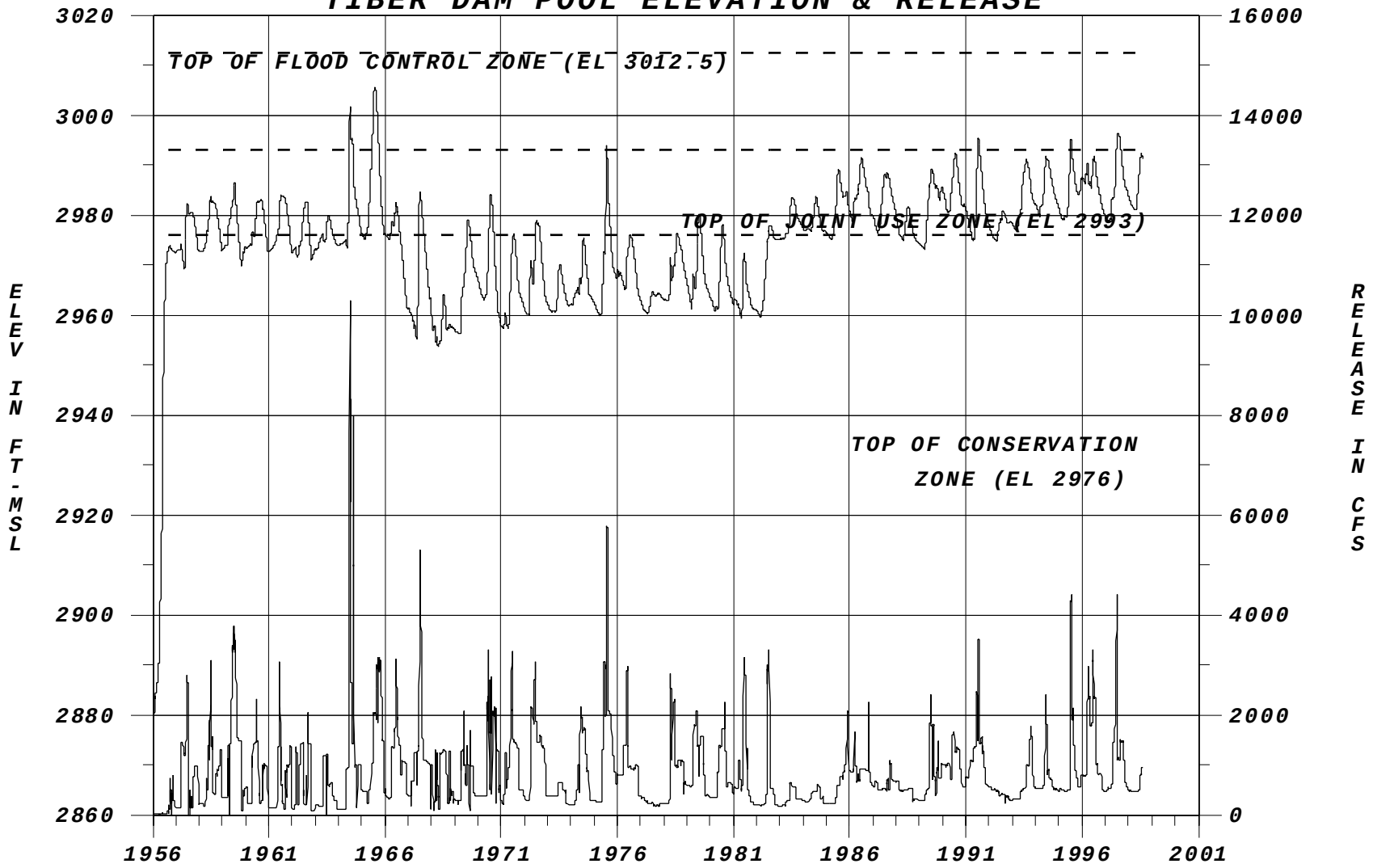


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

TIBER DAM POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

YELLOWTAIL DAM/BIGHORN RESERVOIR
BIG HORN RIVER BASIN, MONTANA
1997-1998 REGULATION

Bighorn Reservoir is regulated by the Bureau of Reclamation (Regional Director) except when the pool level rises into the exclusive flood control zone (3640 ft-msl) or that portion of the joint use zone required for flood control as per Field Working Agreement Dated March 5, 1971. When this occurs, release determination is the responsibility of the Corps of Engineers (District Engineer). Refer to Section VI for the write-up of the flood control regulation for Bighorn Reservoir.

Maximums of Records:

	Daily Inflow-Date	**Daily Outflow-Date**
Highest	29,775 cfs Jul 01 67	24,721 cfs Jul 08 67
2nd	21,068 cfs Jun 11 97	14,947 cfs Jul 03 70
3rd	19,005 cfs Jun 10 81	14,415 cfs Jul 19 95

	Pool-Date
Highest	3656.36 Jul 06 67
2nd	3651.71 Jul 14 97
3rd	3648.55 Jul 13 78

Minimums of Record (since initial fill):

	Pool-Date
Lowest	3583.30 Apr 14 89
2nd	3584.45 Mar 11 70

Report Period: (August 1, 1997 through July 31, 1998)

Total Inflow (AF)
2,842,223, 114% of normal

Total Outflow (AF)
2,929,074, 121% of normal

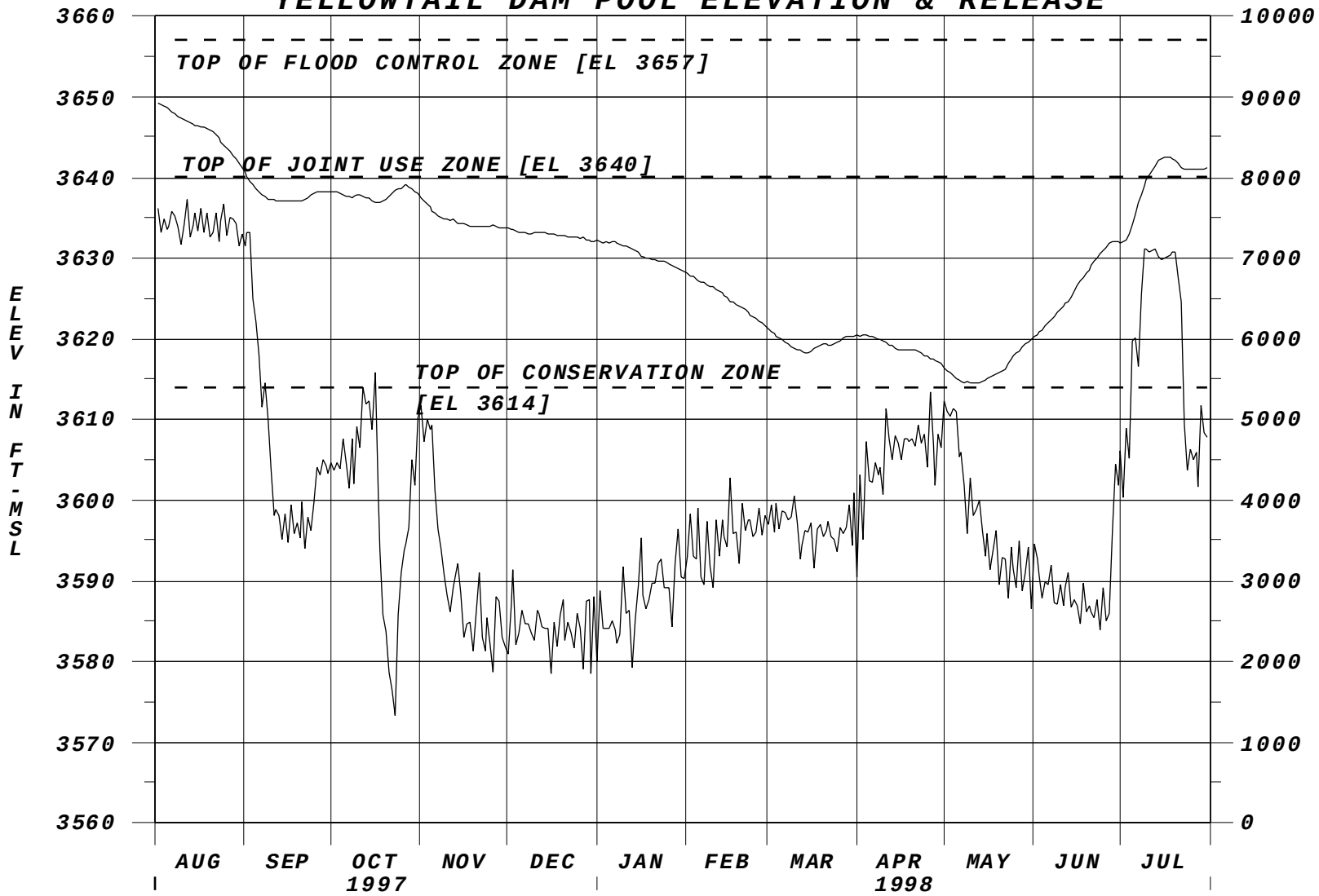
Peak Daily Inflow (CFS)
14,094, Jul 6

Peak Daily Outflow (CFS)
7,729, Aug 11

Peak Pool Elevation (FT-MSL)
3649.25, Aug 1

Minimum Pool Elevation (FT-MSL)
3,614.50, May 9

YELLOWTAIL DAM POOL ELEVATION & RELEASE

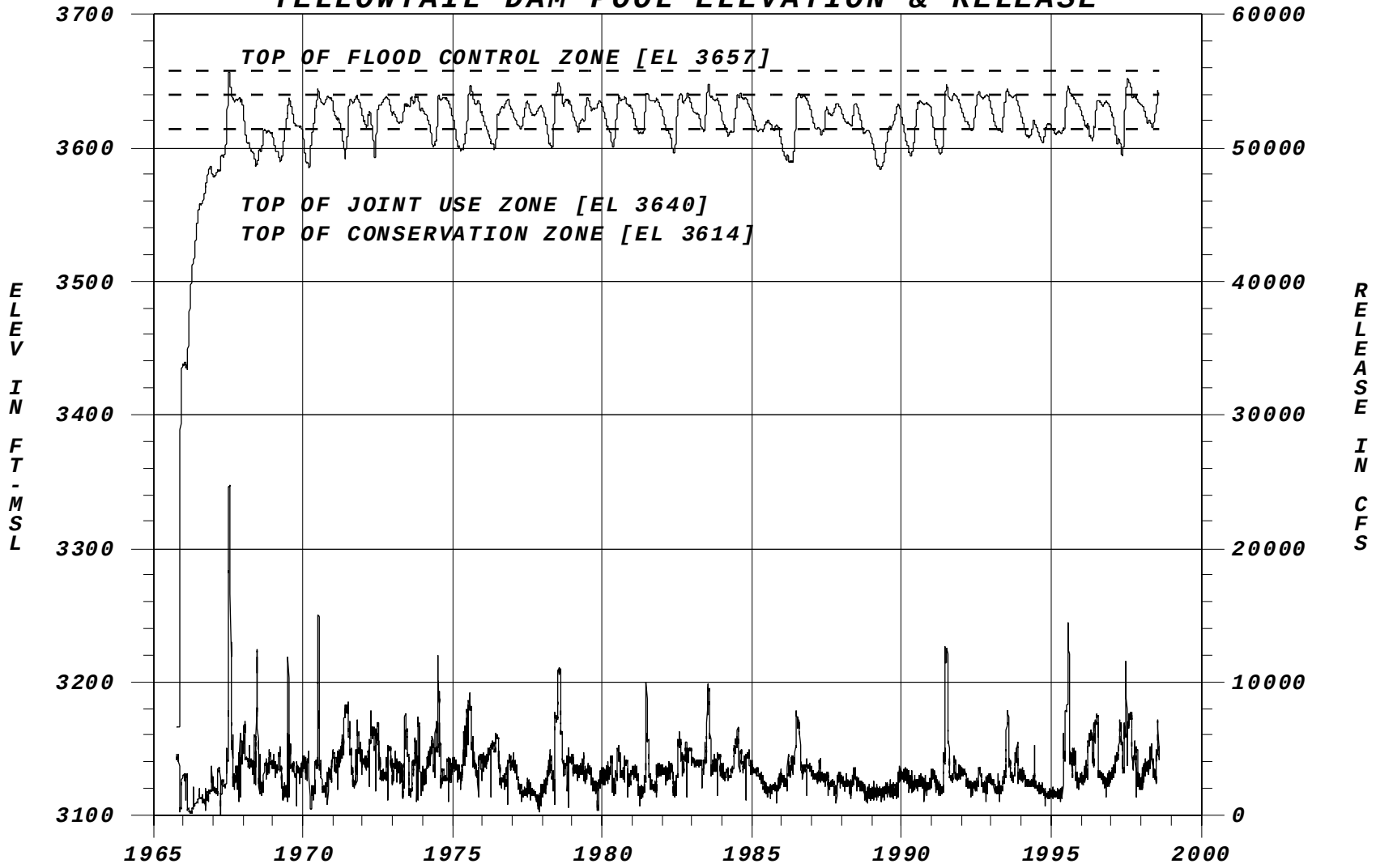


NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____

YELLOWTAIL DAM POOL ELEVATION & RELEASE



NOTE POOL ELEVATION SHOWN BY UPPER PLOT
RELEASE SHOWN BY LOWER PLOT

Prepared By:_____

Reviewed By:_____